ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVI. No. 6. NEW YORK, SATURDAY, FEBRUARY 11, 1905. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . LUCIEN W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada	$3.00
One Year, Foreign Countries	5.00
Single Copies, each	.10
Copies supplied for only one year back, each	.25

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MUNICIPAL LIGHTING.

Certain of the daily papers stated recently that the Brooklyn bridge is lighted "at an annual maintenance cost of $20,000, in round numbers." This statement is criticised in a communication by Mr. Arthur Williams to a New York contemporary. It appears that, not only is the figure $20,000 too small—for the city record shows that the aggregate labor charge for lighting is nearly $24,000—but no allowance is made for fuel, water, maintenance of lamps, maintenance, interest and depreciation of plant, nor for those charges which a private company would have to carry, insurance and taxes. Making allowance for these, Mr. Williams finds that the annual cost to the city should be put down as $58,257, which brings the annual cost of each arc lamp up to $168.94, and that of the incandescent lamps to $29 each. Of course, if we wish to deceive ourselves and use foolish methods of keeping records, we are free to do so. Every municipality likes to think that its business is conducted as efficiently and cheaply as possible, but to use records as inaccurate as this as a basis for estimating the cost of operating a municipal plant is dangerous and wrong.

CENTRAL STATION DEVELOPMENT.

During the past twelve or fourteen years the central electric generating station has undergone great changes. In the early nineties the reciprocating steam engine was the only motive power considered seriously, the contest at that time being between the high-speed and low-speed types. Belts were the usual thing, and countershafts were common. As steam only was considered, the generator-room equipment had little effect upon the boiler house.

The first step was the elimination of the jack shaft and, following it, the belt. The high-speed engine led in this, for generators in those days were normally what would to-day be considered high-speed machines. But the slow-speed engine soon followed, as the dynamo designer gained skill and confidence, for the operating engineer demanded not only direct-connection, with a saving in space, but high operating economy. As the economy of the station was improved, instead of being satisfied, the operating engineer demanded still greater economy. To meet this the internal-combustion engine was taken up and improved in every way, until it may now be considered a dangerous rival of the reciprocating engine, and the merits of the steam turbine at last received some consideration.

The steam turbine has brought about a great change in station arrangement. In general, the station is divided into three parts—the boiler house, the machinery house, and the distributing house. The boiler house contains nothing but boilers, and such auxiliary devices as can not be placed elsewhere. The machinery house contains not only the main generating units, with their exciters and condensers, but all of the operating machines which can be placed there. The distributing house or switch-house contains all the electrical devices for handling the current after it leaves the generator terminals. This arrangement has been adopted for several reasons: it simplifies matters, and is thought to add to the reliability of the plant. As a further guarantee of reliability, each generating unit is made as independent as possible of the others. Thus, the energy represented by the coal pile is distributed among the different boiler houses and does not come together again until, as electrical energy, it is fed into the main distributing buses.

THE ELECTRIFICATION OF AN IMPORTANT ENGLISH RAILWAY.

The English technical papers announce that the directors of the London, Brighton & South Coast Railway have decided to electrify their system, and will start at once upon one branch. The London, Brighton & South Coast Railway is an important system extending south of London, and having an extensive network of lines which carries an enormous suburban traffic.

Some years ago it became apparent that something must be done to relieve the congestion on this system. The terminal stations in London were so crowded that not another train could be added to any of the lines running into them. At the same time the lines within the immediate vicinity of London were losing much of their traffic on account of the many electric tramways which are being run through this district. Experts were secured to report upon the situation, and after a long investigation they reported that the only thing to be done was to electrify the road. This would bring back the traffic which had been lost, and would largely increase the capacity of the terminal stations, since shunting of the trains, which causes much loss of time at the stations, would become unnecessary. At the same time, a better service could be maintained with electrically operated trains. At the time this report was made no particular system was recommended, because at that time the single-phase systems had not been fully developed, and there was a strong objection to the use of a direct-current system with a third rail for distributing the current to the trains. The difficulty with the third-rail system lies in crossing Clapham Junction, where there is a complex network of tracks which would make very difficult the installation of a third rail, and the latter, if installed, would be a menace to trackmen. Now, however, the railway company's engineers are satisfied that the single-phase system offers a solution to all their troubles, and they have decided to adopt it, and will immediately begin equipping the Battersea Park and Peckham Rye section.

The plans proposed for this work present some features differing from any other plans which have yet been made public. There will be no novel features at the power-house, for standard design will be followed there, the generators being driven by steam turbines. Nor will the car equipment show any unusual features, although the car bodies themselves are a compromise between the American and English types. The method of distribution proposed, however, differs considerably from any which has yet been tried. The voltage supplied to the trolley will be 6,000—double that proposed by the Westinghouse Electric and Manufacturing Company and the General Electric Company for their single-phase systems. This high voltage will not affect the motors at all, but it will make necessary a special transformer. The return will be by way of the track, but not through it, for the separate rails will not be bonded together, but to a common return. The collector decided upon is of the bow type.

It would be interesting to know why 6,000 volts was decided upon for the supply system. It is true that doubling the voltage, as compared with the American plan, will not make much difference in the transformers on the car, for transformer designers are not troubled by the comparatively low voltage of 6,000; but it will make extra care necessary for the overhead system. Doubtless, some type of catenary suspension will be used, and special care will be necessary in the selection of a type of insulator. Six thousand volts is not high for a transmission line, but it is high for a line which is at once a transmitting line and a supply line. The higher voltage would enable power to be transmitted economically to a greater distance than the lower voltage, but it has been said that even with 3,000 volts there is no necessity for feeders, the trolley wire itself having ample conductivity. Moreover, in this particular case the line will be cut into sections, each section being fed at a middle point.

The method of returning current seems somewhat peculiar. The rails, as has already been said, are to be bonded to a common return, and not bonded together. This common return is the outer conductor of a concentric cable, the inner conductor being the high-tension feeder. The outlines of the system which have appeared in the English papers give no explanation of this unusual arrangement.

The success of this road will be followed closely by railroads throughout the entire world. Forming, as it does, an important part of the system serving the suburban districts of London, where traffic is very heavy, and having been forced to abandon steam because the maximum possible service by this means had been reached, it will give an excellent object lesson of what will be gained by electrification. At the same time, as one of the first roads to adopt the single-phase system, and because of the peculiarities pointed out above, the performance of the equipment will be watched by railway engineers.

SIGNIFICANCE OF THE HYDROELECTRIC DEVELOPMENTS AT NIAGARA FALLS.

That great power plants are being constructed on the Canadian side of Niagara falls is well known, but probably not many recognize the stupendous character of the work now going on, nor appreciate the relation of the new plants to the total hydroelectric development of the world. The three great power stations now being built will have an aggregate output of 285,000 horse-power, distributed as follows: the Canadian Niagara Power Company, 110,000; the Toronto & Niagara Power Company, 115,000, and the Ontario Power Company, 60,000. The last-named company intends increasing its stations ultimately to 180,000. Comparing the total for the present plans of 285,000 with the grand total for the world, which is given by the *Engineer* (London) as 1,483,000, shows what an important addition to the world's water power the Canadian plants will form. But this is not the whole story, for adding in the additional 120,000 planned for by the Ontario Power Company gives a total of 405,000 horse-power for the new Canadian stations; more than twenty-seven per cent of the world's present hydroelectric power.

It is interesting to sum up the total power development of the Niagara falls district, in use and prospective. On the American side there is about 150,000 horse-power in the three stations. One the Canadian side, along the old Welland canal,

there are two stations with a present output of 26,000 horse-power and a total planned for of 52,000. Right at the falls is the small plant of the International Railway Company, which has an output of 1,500 horse-power. The total is about 625,000 horse-power.

In an excellent description of the work going on now at Niagara Falls, which is contributed to the *Engineering Magazine,* for February, Mr. C. B. Smith says that for a generation at least the Niagara Falls district is not likely to make use of more than 400,000 horse-power. This allows for the large factories now being built there and for the probable development of the district. Should Mr. Smith's estimate prove correct, and he has had excellent opportunities to study the situation, as he was, until recently, engineer for the Ontario Power Company, there will be a number of generators idle or long-distance transmission will have to be resorted to to dispose of the available surplus. Mr. Smith thinks the railroads will avail themselves of the opportunity as soon as they are convinced that they can rely upon the supply.

It is worth while looking at the present state of hydroelectric development for those countries where this has been carried well forward. The following are the figures given in the *Engineer* (London): the United States leads with 527,467 horse-power. Canada comes next with 228,225 horse-power. When the new Canadian plants have been put into service she will push this country closely for first place. Third on the list of countries is Italy with 210,000 horse-power; next comes France with 161,343, and then Switzerland with 133,202 horse-power. Germany has 81,077, and Sweden has 71,000 horse-power. In all other countries the hydroelectric development is small, being only a few thousand horse-power for each.

DISRUPTIVE DISTANCE IN AIR.

Although the sparking distance between needle points has been used to a great extent as a means of measuring high voltages, particularly when such are used for testing purposes, there has always been some uncertainty as to the accuracy of this method. It has long been known that the disruptive distance depends upon the condition of the air, and upon the shape of the terminals between which the spark passes. Just how this was brought about was not clearly understood. In a recent issue of the *Elektrotechnischer Zeitschrift,* Mr. Hugo Grob, of Zurich, describes an elaborate series of tests conducted by himself with a view of shedding light on the subject.

Shortly after he had begun these tests, Mr. Grob was struck by a sudden change in the sparking distance, due to a slight increase in voltage. The curve giving the relation between disruptive distance and voltage showed a decided hump. It was found, moreover, that a slight change in the arrangement of the electrical circuit altered the curve so as to bring this hump at a different point, although the same general shape was maintained. This indicated that here was a phenomenon which might be investigated with profit, and after a careful search the cause was found to be the capacity of the high-voltage circuit which seemed to produce a condition of resonance, with a corresponding rise in voltage. It was found that the point at which this hump occurred in the curve could be controlled by adjusting the capacity of the circuit, but that all of these humps seemed to fall along a fairly smooth curve.

These experiments were conducted with needle points, but Mr. Grob believes that the effect of terminals having other shapes is due principally to their capacity. With a given shape of terminal and a fixed capacity in the circuit, there is no difficulty in obtaining a definite curve. This indicates that the length of spark may be used as a means of measuring approximately high potentials, if the necessary precautions are observed and the circuit be calibrated; otherwise the results are too unreliable to be of value. The circuit may be so adjusted as to bring the hump at a comparatively low voltage or to make it of but slight importance. The curve then follows approximately a straight line, and a simple equation may be used for estimating the voltage. Indeed, this may be done in any case, provided the hump is passed before readings are taken.

GASLIGHTS IN BEDROOMS.

Attention has been called frequently to certain dangers arising from the use of illuminating gas and to the easily observed precautions which greatly reduce, if not entirely remove, the risks. In matters of this kind, and particularly as it is impossible to reach everybody concerned with one warning, the warning should be repeated from time to time.

One danger from the use of gas was touched upon in a recent issue of our esteemed contemporary, the *New York Times,* a newspaper which is ever alive to the public welfare, which is quick to recognize existing evils, and which usually has some well considered suggestion to offer. The following is what it says about leaving gaslights burning in bedrooms:

Frequent casualties emphasize the danger of turning down the gas and leaving it burning "low" all night. This danger exists at all times, but especially in winter, and is much greater in New York, where water gas is supplied, than it is in cities which still depend upon retort gas. The reason for this is that water gas carries on the average four or five times as much carbon monoxide per unit of bulk as retort gas. Carbon monoxide is a very energetic blood poison. It has for the hemoglobin of the blood about four hundred times the affinity of oxygen, and as little as two-tenths of one per cent in air breathed is certain to produce very serious symptoms of heart derangement in persons exposed to it, while in the presence of four-tenths of one per cent no form of animal life can long be sustained.

Gas does not freeze; neither do gas pipes. What may freeze is the vapor of water carried by all gas in larger or smaller percentages. This watery vapor is condensed as frost on the inside of a cold pipe and may build up enough to close it. A very few degrees of heat will reconvert it into water, and when such conversion takes place a pipe which may have been temporarily closed is open again and permits gas to pass through. This happens frequently in dwellings, and explains why a gaslight turned low will sometimes "go out" and gas is subsequently found flowing through the burner.

There are many safe lights for the bedroom, and gas is so unsafe that its use for this purpose can only be attributed to ignorance of the danger it involves at all seasons, but especially in winter.

Gas is to-day the illuminant most widely used in cities. It is as well a valuable fuel. There is no probability of its being driven completely from its well established position, at least for a long time. Therefore the dangers incident to its use should be realized by all who have occasion to use it, either as a source of light, or for heating or cooking.

Annual Dinner of the American Institute of Electrical Engineers.

The annual dinner of the American Institute of Electrical Engineers was held in the grand ballroom of the Waldorf-Astoria, New York city, Wednesday evening, February 8, 1905. About 300 members and guests were assembled, and the dinner was served promptly at 7.30 P. M. Prior to the dinner a reception was held in the Astor gallery, the guests being received by John W. Lieb, Jr., president of the Institute; Mr. Leo Daft, of pioneer railway fame, and a number of other engineers who have had much to do with the development of electric traction. In the Astor gallery there was on view the painting of Dr. Gilbert experimenting on magnetism before Queen Elizabeth. This painting was presented to the American Institute of Electrical Engineers by the Institution of Electrical Engineers, of Great Britain, on the occasion of the International Electrical Congress, held at St. Louis last September. A bust of Galileo Ferraris was also on exhibition.

The grand ballroom, where the dinner was served, was beautifully decorated with festoons of smilax interspersed with incandescent lamps. Upon each table was mounted a centre-piece of ferns and smilax, embellished with numbers of miniature incandescent bulbs. About fifty six-foot Cooper Hewitt mercury vapor lamps were strung around the second balcony, and immediately after the dinner had been served and the tables cleared, these lamps were turned on and a photograph made of the assemblage.

Following this a number of highly interesting biograph views were shown with the apparatus of the American Mutoscope and Biograph Company. The pictures shown included views of the welding of a ten-foot, 1,000-kilowatt generator ring, assembling a huge rotary converter, and a general view of the main aisle in the Westinghouse Electric and Manufacturing Company's works at Pittsburg, Pa. The Manhattan viaduct and other features of the Interborough Rapid Transit Company's system were shown, and then there were several exciting scenes of races between the Empire State express and the new electric locomotive built for the New York Central & Hudson River Railroad Company.

Shortly after ten o'clock President John W. Lieb, Jr., arose to bid the guests and members welcome. He dwelt briefly upon the great strides which had been made in electric traction, and quoted from the history of this progress.

Mr. T. C. Martin was introduced as the traditional toastmaster of the Institute. In a few well-chosen words he introduced Mr. Frank Julian Sprague as one to whom American and foreign engineers owed a great deal for the remarkable work he had performed in the electric field.

Mr. Sprague's address was upon the topic "Art and the Men." He called attention to the fact that, where electric traction had been successful, the conditions obtaining were largely favorable to that success. On trunk lines where steam locomotives were holding their own the question should be taken up in a different manner. There was, however, no road suffering under any conditions that could not be operated by electricity. The great question was not a matter of high speed, but of sustained speed. Just so soon as the passenger and freight traffic on a steam trunk line justified the electrification of that line the line would be electrified. Electrification of trunk lines, he said, was a matter of finance, and not a matter of technical engineering.

Mr. Sprague was followed by Mr. Leo Daft, who replied to the toast, "These Twenty Years." Mr. Daft spoke briefly of the trials and rewards which had come to the pioneers during the last twenty years. He paid a tribute to the men of capital who had stood so solidly behind the engineers, and had given them such great aid in their undertakings.

Mr. Herbert H. Vreeland, president of the New York City Railway Company, responded to the toast, "The Broomstick Train." Mr. Vreeland spoke entertainingly for a short time upon the conditions of passenger traffic in a great city.

Mr. Lewis Buckley Stillwell, electrical director of the Interborough Rapid Transit Company, in reply to the toast, "Traction Above Ground and Under," recited some interesting data in connection with the electrical equipment and operation of the Interborough Rapid Transit system.

Brigadier-General A. W. Greeley, chief signal officer, U. S. A., responded to the toast, "Other Uses of Electricity." He spoke in an interesting manner of the great work which the signal corps of the United States army was doing in bringing intercommunication between the distant points. Within very recent years there has been built by the signal corps sufficient all-American cable to reach entirely around the world. In Alaska a cable had been laid during the last year which would reach from Newfoundland to Ireland. Across Norton sound, in Alaska, a wireless telegraph system was working for 107 miles. This had been in operation for several months without a single interruption. On one occasion thirty-five messages of varying lengths were sent to and fro by this system without having a single word repeated. In the Philippine Islands, in Cuba and in Porto Rico good systems of telephone and telegraph had been instituted, and in the Philippines it is possible to telegraph anywhere in the islands, 1,300 miles north and south, for forty cents.

Besides the president and the toastmaster, the following were seated at the speaker's table: C. C. Schneider, W. G. Ross, James Gayley, L. B. Stillwell, C. A. Coffin, Nikola Tesla, Elmer A. Sperry, General Greeley, Leo Daft, C. F. Scott, R. W. Pope, General Eugene Griffin, E. W. Winter, H. H. Vreeland, T. C. MacCarter, F. J. Sprague, Dr. A. R. Ledoux, Dr. F. B. Crocker, W. B. Potter, C. G. Curtis, W. J. Wilgus, F. D. Underwood, H. H. Westinghouse, Dr. S. S. Wheeler, G. W. Stockley, John R. Freeman, H. Ward Leonard and B. J. Arnold.

Light and Power Plant and Suburban Railway in Santiago De Cuba.

United States Consul Holaday reports that there has been organized in Santiago de Cuba a joint stock company called the Compañía Eléctrica de Santiago, with a capital stock of $300,000 and an authorized bond issue of $300,000 additional. The company operates under a concession given by the president and secretary of the government of the Republic and a charter granted by the municipality of Santiago de Cuba. It proposes to build immediately a plant to supply light and power to private consumers and later to construct a street and suburban railway. The following contracts have been let: to the Babcock & Wilcox Company, of New York, for supplying three boilers of 500 horse-power and one steel smokestack 110 feet high; to the Buckeye Engine Company, of Salem, Ohio, for supplying two stationary engines of 235 horse-power each; to the General Electric Company, of New York, for supplying all the electrical machinery necessary for the equipment of the plant. Mr. José Marimon is president, and Mr. Eduardo J. Chibas, vice-president and managing director.

The Narragansett Electric Lighting Company's Plant.

THE Narragansett Electric Lighting Company, Providence, R. I., supplies current for light and power to the city of Providence and the territory included within a circle of about fifteen miles radius. The central station is located in Providence, at the corner of South and Eddy streets, on the Providence river, and consists principally of three buildings—boiler house, engine room and dynamo room. The buildings are all of brick, with one main floor.

The boiler house is placed across the end of the engine and dynamo houses, which are arranged side by side. It is seventy feet by 120 feet, and twenty-four feet high. In it are installed twelve 375-horse-power Babcock & Wilcox boilers, which are set in batteries of two. The boilers are arranged in two rows of three batteries each, facing each other, with a passage about ten feet wide between them. Each boiler has 216 tubes four inches in diameter, and three drums thirty-six inches by sixteen feet. They are fitted with Roney mechanical stokers, the latter being driven by a shaft which runs the length of the boilers. The shaft is driven by a seven and one-half horse-power induction motor at one end, and a seven and one-half horse-power engine at the other end. Coal, at present, is wheeled into the building in wheelbarrows, and dumped on the floor, whence it is shoveled to the stoker hoppers. Plans have been completed, however, for a complete coal-handling equipment, with overhead storage bins.

Steam is taken from each boiler by an eight-inch nozzle, and is fed to a sixteen-inch header over each row of boilers. The header runs to a twenty-inch main steam pipe, which conveys the steam to the engine room. All the steam pipes in the boiler house are steel castings, some of them being twelve feet long and three-quarters of an inch thick. The flanges on the twenty-inch pipe are two and one-half inches thick, and all pipes were bored out a distance equal to twice the flange thickness from the end in order to discover blow-holes.

Each battery of boilers is supplied with a Green economizer, each economizer containing 256 tubes. The main flues from each set of boilers are eight feet by six feet. They lead to a brick stack fourteen feet in diameter and 250 feet high.

Water is supplied to the boilers by two Worthington duplex, outside-packed feed pumps, fifteen by ten by fifteen inches. The feed pipe at each boiler is two and one-half inches in diameter. The feed water, before entering the boiler, passes through a Gleaner feed-water heater, which has 750 square feet of heating surface. The steam auxiliaries in the engine room and boiler room exhaust to this heater. The heater is provided with horizontal U-tubes, arranged in series, the steam entering at the top and passing through to the bottom. The feed water is raised to a temperature of about 170 degrees Fahrenheit, and the condensed steam leaves the heater at a temperature of about five degrees above that of the entering water. In addition to the exhaust from the auxiliaries, all the drips

ENGINE ROOM, NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

from the main engines are passed to the heater. City water is used in the boilers. The boiler pressure is 175 pounds.

The engine house is 200 feet by sixty feet, and has a wing forty-five feet by 100 feet. It contains all the engines used in the plant, except one 1,800-horse-power engine, which is installed in the dynamo house. Three engines, aggregating 3,600 horse-power, drive a shaft underneath the floor of the dynamo room, the generators for city lighting, and five direct-current generators being belted to this shaft. The shaft is 145 feet long, and varies in diameter from seven inches to six inches. The engines are:

One 600-horse-power, Allis triple-expansion engine running at 100 revolutions per minute. The cylinders are fourteen inches and twenty-four inches and thirty-three inches by forty-eight inches. The flywheel is seventeen feet by forty-eight inches. Steam is supplied to this engine by a five-inch pipe. The exhaust steam from the engine is passed to a jet condenser with a steam-driven, twin vertical air-pump nine inches by twenty inches by twelve inches. This engine is the first triple-expansion engine made in the United States for land service.

One 1,500-horse-power, Allis triple-expansion engine with cylinders twenty-two and thirty-six and fifty-two by forty-eight inches stroke, running at ninety revolutions per minute. The flywheel of this engine is twenty feet in diameter by eighty inches face. Steam is supplied to the engine by a seven-inch pipe, and the exhaust steam passes through a jet condenser equipped with a Blake twin vertical air-pump. The cylinders of the air-pump are twelve by twenty-eight by eighteen inches.

One 1,500-horse-power Allis cross-compound engine with cylinders twenty-four and fifty inches by forty-eight inches, running at 100 revolutions per minute. This engine was originally a triple-expansion engine, but has been changed to a compound. The flywheel is seventeen feet in diameter by seventy-four inches face. Steam is supplied through an eight-inch pipe, and the exhaust steam goes to a Blake jet condenser fitted with a twin vertical air-pump having cylinders twelve by twenty-five by eighteen inches. This engine is used as a reserve for the city lights. These three engines are connected to the shaft by three-ply belts. No dressing is used on the belts, and no trouble has ever been experienced with them. When an engine is not in use, its driven pulley is disconnected from the shaft by opening a jaw-clutch.

In addition to the above engines there are three engines for supplying direct current. These engines were all built by the International Power Company, Providence, R. I., and are rated at 750 horse-power each. They are cross-compound engines with cylinders nineteen and thirty-six by forty-eight inches stroke, and run at ninety revolutions per minute. The engines are direct-connected to 500-kilowatt, direct-current generators, and are fitted with direct-connected air-pumps and jet condensers. These engines are installed in the wing.

DYNAMO ROOM, SHOWING SERIES-ARC LIGHT MACHINES, NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

In the main engine room for alternating-current work there are three 750-horse-power, cross-compound engines with cylinders nineteen and thirty-six by forty-eight inches. The engines run at ninety revolutions per minute, and are direct-connected to 500-kilowatt, 2,000-volt, three-phase, sixty-cycle generators with revolving armatures. These engines have direct-connected air-pumps and jet condensers, the air-pump cylinders being thirty-two inches by ten inches. Steam is supplied to these engines through a

seven-inch pipe on each engine. All of the foregoing engines are installed in the main engine room and its wing.

In addition there was installed in the dynamo room about a year and a half ago an 1,800-horse-power Rice & Sargent cross-compound engine with cylinders twenty-eight and fifty-six inches by forty-eight inches stroke. The engine runs at ninety revolutions per minute, and is direct-connected to a 1,200-kilowatt, 2,000-volt, three-phase, sixty-cycle, revolving-field generator. The engine has a jet condenser, with a Blake twin vertical air-pump with cylinders fourteen by thirty-two by twenty-one inches. Steam is supplied through a ten-inch pipe.

All the engines used in the plant are of the Corliss type. They are fitted with Monarch engine-stops, which can be operated from the switchboard or from a small panel-board in the engine room. The current to operate the stops is supplied by a one-half-horse-power motor-generator, which takes current at 250 volts and generates current at ten volts. The engines for alternating-current work are equipped with the Rites inertia governor. The other engines have the ordinary fly-ball governor.

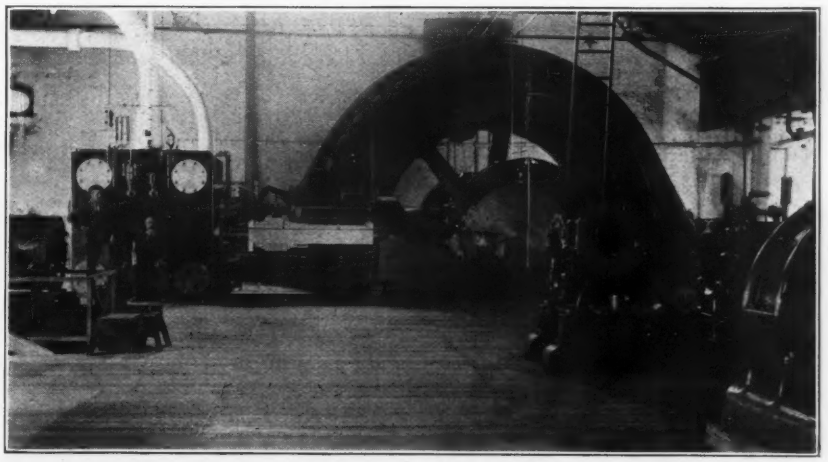
All the oil used in the engines is filtered, and is then lifted to a gravity tank by a two and five-eighths-inch by five-inch triplex pump, which is driven by a one and one-half horse-power Holtzer-Cabot four-pole motor. The motor runs at 1,650 revolutions per minute, and is geared to the pump, which runs at sixty revolutions per minute.

The engine room is lighted by ten direct-current arc lights, and about eighty sixteen and thirty-two-candle-power, 235-volt incandescent lamps.

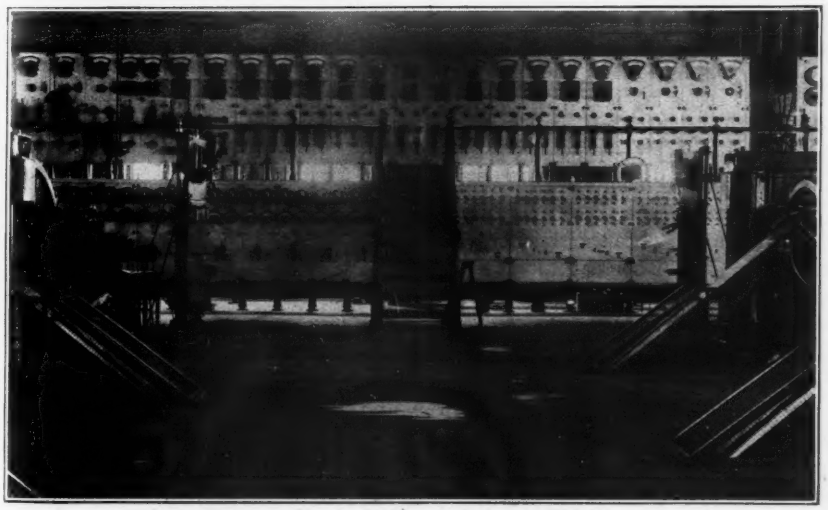
The dynamo room is 60 by 200 feet. At the west end of the room are installed eighteen 125-light "Wood" arc generators, which are used for the series arc lighting in the close fire district of the city of Providence. These machines run at 500 revolutions per minute, and generate ten amperes at 6,250 volts. The machines are arranged in four rows, two on each side, and are belted to the shaft heretofore mentioned, the belts going through the floor.

In addition to the "Wood" machines there are in the dynamo room one 200-kilowatt, two 225-kilowatt, one 270-kilowatt and one 325-kilowatt direct-current generators, also belted to the shaft. These generators are run in parallel with the direct-current generators in the wing of the engine room. All direct current generated, with the exception of that for the series arc lighting, is at 500 volts. The field current on all machines is taken from the mains at 500 volts. On each engine is a pilot lamp, which indicates the closing of the field-switch. The current used in fields is metered.

In addition to the generators there is a 500-kilowatt motor-generator set with an alternating-current induction motor and direct-current generator. This is used when the direct-current load is light, as from midnight to morning, and on Sundays. The induction motor is three-phase, and operates at 2,200 volts. The motor-generator set is arranged so that it may be started either from the direct-current or the alternating-current side. As a matter of fact, the usual method of starting is to use direct current, and after the machine is up to speed to throw the load over on the induction motor.



1,800 Horse-Power Engine and Generator in Dynamo Room, Narragansett Electric Lighting Company, Providence, R. I.



Main Switchboard, Narragansett Electric Lighting Company, Providence, R. I.

Two motor-driven boosters of 150-kilowatts each are used for the battery system, boosting from the bus-bars to the battery.

In addition to the above equipment the company has contracted for two 2,000-kilowatt and one 800-kilowatt Curtis turbines, to be used for direct-current work.

For series incandescent lighting alternating current is used. The current is taken from the generators and passed through fifteen General Electric constant-current, air-cooled transformers, located on the main floor, just beyond the "Wood" series arc machines. These transformers are of thirty-five kilowatts capacity and give 5.5 amperes current. The primary voltage is 2,200.

For the long-distance transmission alternating current is stepped up from 2,200 volts to 10,000 volts in three 250-kilowatt, oil-cooled transformers in the basement. The transformers are all delta-connected.

The switchboard is installed at the west

end of the dynamo room, and consists of three main panels, which are used, respectively, for the alternating-current distribution, direct-current distribution and the series arc lighting. A smaller panel is used for the long-distance, alternating-current transmission line. The alternating-current board is on the left-hand side,

The direct-current switchboard is on a gallery above the alternating-current board. It consists of ten feeder panels and sixteen output panels. Each of the feeder panels carries an ammeter, a rheostat, and two single-pole, double-throw knife switches, which may be used to throw in either set of bus-bars. The output

INTERIOR OF STORAGE BATTERY STATION, NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

and consists of four generator panels, ten feeder panels and one total-output panel. Each panel is of white marble, two feet by five feet. On each of three of the feeder panels are three 200-ampere ammeters, a rheostat, an oil switch on the back of the panel, a voltmeter switch, a field switch and a double-pole, double-throw knife switch for synchronizing. This double-pole, double-throw switch changes the position of the weights on the governor of the engine, thus varying its speed. There is also a push-button which operates the emergency stop on the engines. The fourth feeder panel is the same as the other three, with the exception that there are three 500-ampere ammeters instead of three 200-ampere ammeters. The ten feeder panels each have two Fort Wayne wattmeters of varying capacity, two ammeters, and an oil switch on the back of the panel.

There are two sets of bus-bars, each of which carries its own load, but the two sets can be thrown together or kept independent. This eliminates the danger of a circuit being cut out through a breakdown of one of the engines.

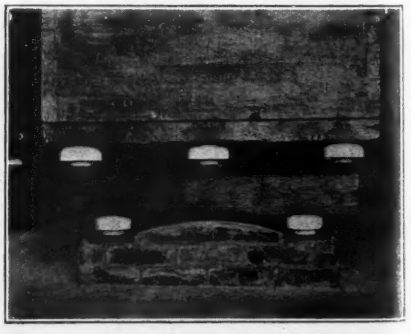
panels carry an ammeter, a wattmeter and two single-pole, double-throw switches.

On the main floor, on the right-hand side, is the series arc board, consisting of seven panels. These are all fitted with stab switches used for throwing any circuit on any machine.

In addition to these three main boards there is a long-distance transmission board on the gallery. This panel carries two wattmeters and two oil switches. The oil switches are located on the wall above the panel, and are separated by soapstone slabs.

The storage battery station is located about 2,400 feet away from the station, and practically at the centre of distribution of the system. The battery consists of 296 cells of forty-three plates each. The original rating was an output of 840 amperes at an eight-hour rate. The battery has been in commission about five years, and was originally furnished by the Electric Storage Battery Company, of Philadelphia, Pa. All renewals, however, have been made by the National Battery Company, Buffalo, N. Y., and by the Gould Storage Battery Company, New York city. No change has been made in the battery since it was installed, except in the method of supporting the tanks. The present method of support is shown in the illustration. A double tier of porcelain insulators is used, the first tier being mounted on four brick piers. These piers are capped with hard pressed tile, thoroughly impregnated by boiling in paraffin. On the tile are triple-petticoated insulators of porcelain. Longitudinally with the cell, and resting on the four insulators, are two hard pine sticks, each four by four and three-quarters inches. These sticks are painted with acid-proof paint. On each stick are placed three tiles boiled in paraffin, and on the tiles is placed a second tier of porcelain insulators. The tanks are supported on this second tier of insulators. From the floor to the bottom of the tank is a distance of twenty and three-quarters inches. The floor under each cell is pitched from a point under the middle of the cell to the aisle between them at an angle of about twenty degrees. This allows any surface water or drip from the tank to drain off rapidly. The changes made in the method of installation consisted in the building of the brick piers and putting in the lower tier of insulators. Originally the pine stick rested directly on the floor.

The distribution system is on the three-wire, 500-250-volt system. The three-wire distribution commences at the storage battery, all the machines at the station being arranged for two-wire distribution. The neutral wire in all cases is grounded. In the close fire district of the city and in a portion of the outlying district the wires

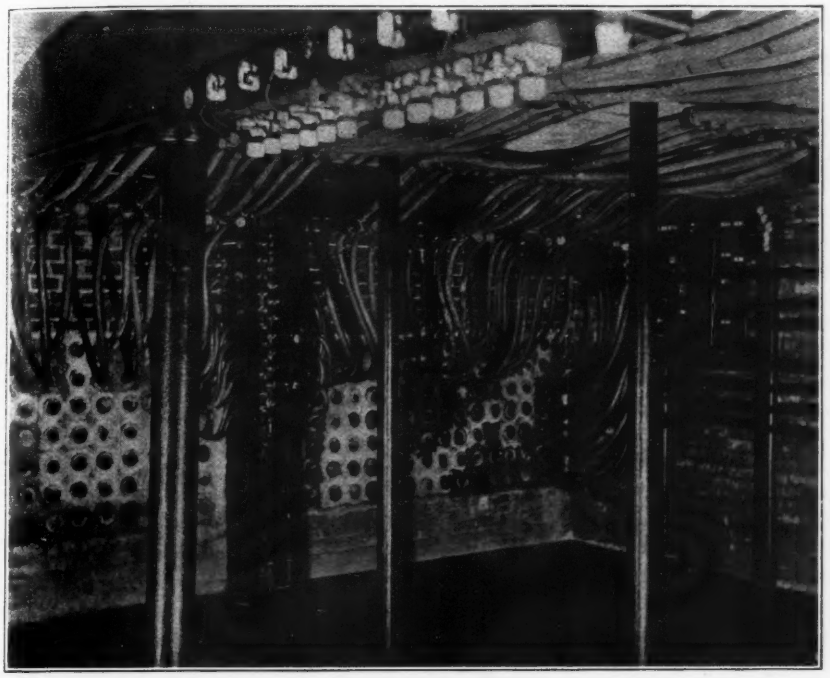


METHOD OF SUPPORTING STORAGE BATTERY CELL, NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

are carried underground in conduits. In five years of operation not a single fault has developed in the insulation in the conduits.

The company has two substations, one located at Warren, and the other at Warwick. The station buildings are identical. They are of brick, with granite trimmings,

and are entirely fireproof. The equipment of the station at Warren consists of three sixty-five-kilowatt, 125-light, 5.5-ampere, 10,000-volt General Electric constant-current transformers, and four seventy-five-kilowatt, oil-cooled, Westinghouse step-down transformers. These step the line voltage from 10,000 to 2,200 volts.



CABLE VAULT AT STORAGE BATTERY STATION, NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

The equipment at the Warwick station consists of five sixty-five kilowatt constant-current transformers of 125 lights capacity, and four 150-kilowatt, step-down transformers, stepping down from 10,000 to 2,200 volts. The switchboard at each station has General Electric oil switches and instruments. All the high-tension switches are in the basement, and are controlled from the floor above. The stations have been built about one year.

The total connected load on the central station consists of 2,105 Thomson-Houston open arc lamps and 128 6.6-ampere enclosed alternating-current series arc lamps. There are also 5,024 5.5-ampere alternating-current series incandescent lamps, and 115,757 alternating-current multiple incandescent lamps. There are 1,427 direct-current multiple arc lamps, and 502 alternating-current six-ampere enclosed multiple arc lamps. There are 89,300 direct-current multiple incandescent lamps. The motor load consists of 105 alternating-current motors, aggregating 505 horse-power. There are 926 direct-current motors, aggregating 6,300 horse-power. The total connected load is equivalent to 364,473 sixteen-candle-power lamps.

High-Speed Railway Propositions in Germany.

Ever since the experiments in 1902-1903 with high-speed electric traction over the special line between Berlin and Zossen were concluded, and the results analyzed and recorded, the question of an electric railway for rapid service between Berlin and Hamburg has been a topic of interest and constant discussion in the daily and technical press of Germany.

The Zossen experiments demonstrated that, given a straight, well-laid and well-balanced track, with the best modern construction, a speed of 120 miles per hour was possible and safe. It was shown that, to propel a single car carrying the requisite equipment, and with accommodations for sixty passengers, at a speed of 110 miles an hour, 1,300 horse-power was necessary, and this was increased to 2,000 horse-power when the speed was raised to 120 miles an hour. At the latter velocity 1,100 horse-power was required to overcome the air resistance alone.

It was found that to keep on the rails and run steadily the car must be heavy, and its running gear skilfully adapted to slurring over the slight and unavoidable irregularities of the track. For this reason light cars are impracticable for speeds over eighty miles an hour. At higher speeds the lateral oscillation becomes so great as to make the car dangerous. At such high speeds curves must be avoided, or must have a radius of not less than a mile; otherwise the speed must be reduced in passing them. There is at present no steam railroad of any important length in any European country—except possibly Russia—that is sufficiently straight to meet the requirements of high-speed service.

According to United States Consul-General Frank H. Mason, Berlin, Germany, two propositions have been submitted for the construction of a high-speed line between Berlin and Hamburg. The distance is 177 miles, which could be shortened by a new direct line to 155 miles. The country between the two cities is generally level and well adapted to the construction of a high-speed line. The ordinary traffic between Berlin and Hamburg is about 1,200 persons per day. The average fare is $3.80, and the fastest time made on the best steam train is three hours and thirty-two minutes. The accommodation trains take from five to six and one-half hours.

One proposition, submitted by Siemens & Halske, contemplates a single-track line on which a train would be despatched from each terminus every two hours, or oftener if necessary, the two meeting and passing each other at the midway station of Wittenburg, and making the through run in one hour and fifty-five minutes. Such a line, equipped for service, would cost, according to the estimates submitted, $16,666,000. In the opinion of Siemens & Halske this road would carry 520,000 passengers per year, and if each paid $3.57, the road would earn a profit above the interest and working expenses.

The second proposition, submitted by the Allgemeine Elektricitäts Gesellschaft, contemplates a double-track line on which trains would travel at 100 miles an hour, making the through trip in one hour and twenty-five minutes. The cost of the road would be $29,750,000. If a speed of 125 miles an hour were to be maintained, the equipment would cost $35,700,000. At the proposed rate of fare—$3.57 for an ordinary seat, and $1.19 extra for a section *de luxe*—it would be necessary to transport 850,000 passengers yearly to show a profit over interest and running expenses. This plan contemplates trains of from one to four cars, according to the requirements of travel. Each train will be, in all respects, an independent unit.

Should such a road be built, there is some doubt whether it would pay, and it would also compete with existing roads. It is a question whether the Prussian government will consent to sacrifice the bulk of its passenger business on an important trunk line, and incur an expenditure from $16,000,000 to $30,000,000 in order to enable the public to save from one and one-half to two hours in the trip from Germany's capital to its chief seaport.

DISTRIBUTION AND DOLLARS.[1]

BY C. H. WILLIAMS.

INTRODUCTION.

Every problem which arises in this branch of engineering may be reduced to a dollars and cents basis, and the engineer of the present day is called upon not only to reach a certain clearly defined result, but to accomplish it with due regard to the investment and expenses entailed.

Engineers are gauged by the results which they obtain, and in this particular line the gauge is most likely to be graduated to dollars or dividends, and the dividends will not be long forthcoming unless good service is rendered, while good service can not be secured without following sound engineering principles.

FACTORS REGULATING THE SIZE AND NUMBER OF FEEDERS TO BE INSTALLED.

When considering the several losses which are to be dealt with in distributing systems, it is but natural to start at the generating station and consider the losses in the regular order in which they are met as the current is conducted from the generating station, over the distributing system to the consumer's lamp.

On leaving the station the question of line construction is the one which naturally first demands our consideration.

The load which is carried on the several circuits depends upon local conditions, the two most important of which are the average length of the feeders and the operating cost of generating the current.

The copper losses in the feeders for any assumed load, figured on the operating cost of generation, compared with interest on line investment, fix the load to be carried; for example, assume the current to be generated at 2,000 volts, and that for a load of 100 amperes a drop of 200 volts is allowable, with an average length of feeder of two miles, which would require the use of 1-0 wire; assume further, that this load of 100 amperes for two hours per day per year represents the copper loss, which is 14,600 kilowatt-hours. This, at a generating cost of two cents per kilowatt-hour, amounts to $292. If a 200-ampere load has been allowed on the same size of wire, the copper loss would amount to $1,168.

Figuring the copper wire at eighteen cents per pound strung, gives for the two sides of the circuit of two miles 21,120 feet, and allowing four per cent for slack and tie wires, gives a total length of 21,965 feet of wire.

[1] Read before the Northwestern Electrical Association, January 18, 1905.

The weight of 1-0 wire is 400 pounds to the thousand feet, which gives a weight and total cost of 8,786 pounds and $1,581.48, respectively, while the interest at six per cent and depreciation at three per cent, which covers the failing of the insulation for which the price of copper is paid, aggregating nine per cent, amounts to an annual cost of $142.38.

On the previous assumption that the load is equivalent to 100 amperes in the one case and 200 amperes in the other, at 2,000 volts, two hours per day, 365 days in the year, there is an annual output of 146,000 kilowatt-hours in the one case, and 292,000 kilowatt-hours in the second, which, divided into the copper losses plus the interest and depreciation, amounts respectively to 0.00295 per kilowatt-hour for 100 amperes, and 0.00448 per kilowatt-hour for the 200-ampere load, which shows conclusively that the 100-ampere circuit is the more economical.

From the above example it follows that we can not predetermine a certain drop which shall be allowed in every case, but each must be worked out for itself.

In secondary work the practice is becoming more and more common of making an interconnected, three-wire network, which allows of close secondary regulation throughout large districts, and also does away with a large percentage of idle transformer capacity, which, consequently, reduces the iron losses, but as this question of transformer iron loss is best taken up by itself, its discussion will not be considered at this point.

CHOICE OF SIZE OF TRANSFORMERS AND SECONDARY FEEDERS.

Conditions, such as active lights per 100 feet of territory fed, determine the proper sizes of transformers and feeders, and to facilitate ready interchanging, and prevent the necessity of carrying half a dozen different sizes of fuses and supplies; multiplicity of sizes of transformers and secondary feeders should be avoided.

Determining or estimating the load, the sizes of transformers depend upon whether the load is scattered over a large territory, or bunched within comparatively narrow limits, and the difference between the interest and depreciation on the transformer investment, together with the cost of current for iron losses for the several sizes of transformers under consideration, on the one hand, and the corresponding interest and depreciation on the investment required for the secondary copper, together with the secondary C^2R loss on the other hand, determines the size of transformer to be used.

It is good practice to adopt some standard size of transformer for residence lighting which covers the conditions for the larger part of the territory under consideration, and to adopt a larger size for the business districts. The number of sizes will then be cut down to two, and a careful study of the conditions will generally demonstrate that this is advisable.

REGULATION AS AFFECTING RENEWALS.

The matter of regulation may be figured for the cost of lamp renewals—provided an accurate record is obtainable of the number of connected lamps, whereby the consumption per lamp per year may be calculated.

If we assume the use of 3.5-watt lamps, and have nearly perfect regulation, and find the average consumption per lamp per year to be twenty kilowatt-hours, the cost of renewals for each lamp figures out to be the cost of the lamp, plus the cost of the labor changing and photometering each lamp, times the connected load in lamps and on the assumption of a 750-hour life, the actual cost for lamp renewals for the system is as follows:

A sixteen-candle-power, 3.5-watt lamp costs seventeen cents and consumes fifty-six watts, and if there is a consumption of twenty kilowatt-hours per lamp per year, each lamp will burn 357 hours per year, or there will be 357-750, or 0.0476 lamp renewals per year, which amounts to $0.0809 per year or $0.004 per kilowatt-hour. The cost of photometering and the labor of changing amount in practice to a cent and a half per lamp or $0.0071 per lamp per year, or $0.00035 per kilowatt-hour, giving a total cost for lamp renewals of $0.00435 per kilowatt-hour.

With a variation of voltage of but one per cent, the life of the lamp drops to 615 hours, which gives 0.58 lamp renewals per annum, which amounts to 0.0986 per year, or 0.00493 per kilowatt-hour, while the labor renewing and photometering amount to 0.0087, or $0.0043 per kilowatt-hour, making a total cost of lamp renewals of $0.00536 per kilowatt-hour, which is an increase of 0.00101 per kilowatt-hour, or for a station with 42,000 lamps connected with an average consumption of twenty kilowatts per lamp per year, and money available at six per cent, $14,140 could be spent to better the conditions of regulations if this one per cent variation could be wiped out, the interest on this amount just equaling the money saved by the decreased lamp renewals.

With two per cent regulation the cost would be 1.48 times the above, and with

four per cent regulation the cost for lamp renewals would be 1.48 times that for two per cent regulation. The matter of regulation, then, is a very important one to the central station, other than the consideration of the question of satisfactory service.

NECESSITY OF KEEPING ACCURATE DISTRIBUTION RECORDS.

In considering the connected load on several circuits and on different transformers, it is necessary to know not only the candle-power of the lamps, but the efficiency and voltage as well, for, should a district be designed for high-efficiency lamps of 3.1 watts per candle-power, and then be supplied with four-watt lamps, the entire system would be radically wrong, and satisfactory service could not be given because of the substitution of four-watt lamps in the place of 3.1-watt, the capacity of the lines and transformers as well as the generating apparatus, boilers, engines and dynamos would have to be increased practically thirty per cent.

Herein lies one of the strongest arguments which can be advanced in favor of having the lighting company furnish free lamp renewals, for in no other way will it be possible to control the installation of proper lamps upon its lines.

MEANS FOR OBTAINING SATISFACTORY REGULATION.

Turning to the station as the source of regulation, it is found that the only way possible to accomplish it is to install sufficient feeder regulators on the various circuits and to provide either compensating voltmeters or pressure wires, regulating each circuit separately by hand. In some stations automatic regulators may be made to take care of the changes by properly changing the excitation of the generator, but in the larger stations where of late large polyphase current machines are being operated, it is next to impossible to keep the load sufficiently well balanced to maintain equal secondary pressures on the different phases without the aid of circuit regulators working through a considerable range.

In Madison the regulation is obtained by supplying two of the six circuits with feeder regulators, and after paralleling the generators and exciters, regulating them as one unit automatically from a centre of distribution of one of the remaining circuits through a pressure wire controlling an automatic regulator, and very satisfactory results are obtained in this way.

The automatic regulator used at Madison is a Chapman voltage regulator, built by the Belknap Motor Company, and five years' use has proved its worth. It consists of a relay connected to a pair of No. 6 pressure wires run to the secondary centre of distribution of a primary circuit; a rheostat is connected into the fields of one of the exciters, and a pair of working solenoids operate the rheostat. An arm carrying contact shoe is attached to the cores of the solenoids, the latter having two windings, one of which is fed with the relay current, and this, in turn, induces a current in the secondary in the same direction, thereby preventing sparking.

Having secured proper station regulation and proper line installation, the next step is to see that suitable transformers are properly located.

TRANSFORMER LOSSES AFFECTING DISTRIBUTION COSTS.

The first essential in successful electric lighting is continuity of service, and for this reason it is very important to know that the transformers which are installed are going to withstand any insulation strains to which they may be subjected.

Before placing in service, each transformer which stands between ordinary consumers' circuits and primary circuits subjected to dangerous pressures should be subjected to a test of at least five times the normal difference of potential between the various parts to which it will be subjected in practice, and when transformers on transmission lines are used on voltages exceeding 7,500, it is customary to subject them to a strain of twice the voltage for which they were designed.

The next important item, and a very important one, is that of the question of transformer core loss, for this represents the principal difference between the power generated at the station and the power for which the consumer pays. As this is a dead loss, and one which goes on all the time that the circuit is alive, it is very obvious that its magnitude is a matter worthy of careful consideration by the central station manager. This matter also deserves careful consideration in determining the capacity of transformers which are selected as standards, as the percentage core loss varies as the sizes change, the core loss in a five-kilowatt transformer being nearly double that of the similar losses per kilowatt capacity which are found in a like fifty-kilowatt transformer of some standard makes.

HEATING EFFECTS IN TRANSFORMERS.

Next comes the C^2R loss in both the primary and secondary windings, which, as a direct loss, is not so important, as lighting transformers are usually operated but a few hours per day at full load, but the C^2R loss, together with the core loss, determines the heating in the transformer, and the rise of temperature determines the ultimate capacity, as a high temperature soon deteriorates the insulation, causing it to weaken, break down and give away eventually. Heating in the transformer also causes the iron to age, and this in turn increases the core loss.

Referring to the report of the committee on standardization, we find the following, *viz.:*

"In the case of transformers intended for intermittent service, or not operating continuously at full load, but continuously in circuit, as in the ordinary case of lighting transformers, the temperature elevation above the surrounding air temperature should not exceed fifty degrees centigrade by resistance in electric circuits, and forty degrees centigrade by thermometer in other parts, after the period corresponding to the term of full load. In this instance the test load should not be applied until the transformer has been in circuit for a sufficient time to attain the temperature elevation due to core loss. With transformers for commercial lighting the duration of the full-load tests may be given as three hours, unless otherwise specified."

It is not safe to take temperature readings in the oil of oil-cooled transformers and operate the transformer at such a load that the oil reaches even a comparatively high point, as in many transformers the circulation between the coils is so poor that a very dangerously high temperature may exist in the interior of the coils, while the oil may show but a comparatively low reading. The rise in temperature should be arrived at by measuring the resistance of the coils.

The actual capacity of a transformer in reality depends to a very large extent on its ability to dissipate the internal heat, and if means can be provided for getting rid of this heat and preventing high local temperatures, the actual capacity of a transformer can frequently be safely increased far beyond its rated capacity.

An extreme case may be cited where two fifty-kilowatt booster transformers are made to carry a load of 250 per cent of their normal rated capacity.

This is accomplished by means of a small circulating pump which draws off the cooling oil from near the top of the oil surface, and circulates it through a system of iron pipes built up in the form of a steam radiator; cold water is allowed to run down on the outside of the cool-

ing pipes, and the oil, after being cooled, is forced back into the bottom of the transformer cases.

Before this scheme was resorted to the oil temperature rose to 180 degrees Fahrenheit when operating the transformer at 100 per cent overload, whereas the temperature is easily maintained below seventy-five degrees when the transformers are operated at 250 per cent of their normal load when use is made of the oil-cooling system.

REGULATION OF TRANSFORMERS.

Another item of importance is the inherent regulation of a transformer, and by regulation is meant the ratio of the drop of secondary voltage from no load to full load. With transformers of poor regulation on the circuits, difficult problems will enter when an endeavor is made to give all consumers equal and normal voltage, which would necessitate pronounced changes in secondary feeders, or a still more objectionable change in a substitution of lamps of different voltages and efficiencies.

The insulation having been proven satisfactory, the interest on the investment for the transformer, together with the core loss in kilowatts, times twenty-four hours per day every day in the year, times the generating cost per kilowatt-hour, and the full load copper loss, times the equivalent number of hours during which the transformer would operate full loaded, times the generating cost per kilowatt-hour, give the data necessary for finding the actual cost per annum of operating each type of transformer, when operating on a twenty-four-hour lighting load, so that the other conditions being the same, the most desirable type is determined.

It is apparent from the foregoing that the conditions under which the transformer is to be operated have much to do in determining the value of the different factors, for instance, the iron loss goes on as long as the transformer remains in circuit, while the copper loss is nil so long as no current is flowing, and increases with the square of the current as the load is increased.

If, then, a transformer is to be selected for a lighting load where it is on the circuit twenty-four hours per day, and furnishes a total amount of power equivalent to its full load for but two hours per day, it is of first importance, so far as the losses are concerned, to obtain a transformer with a low iron loss, and, on the other hand, if the transformer is to be fully loaded all day, it is much more essential that the copper loss should be as low as possible.

In any case, the two losses must be taken into consideration, and the expenses figured for each before an intelligent selection can be made.

RECORDS OF TRANSFORMER TESTS.

It is essential that a record be had not only of the performance of the transformer at the time when it is put upon the line, but also a record should be kept of periodic tests, in order that any change which takes place as the apparatus ages may be watched and recorded, as it may be advisable to discard it and substitute other apparatus if the change is a material one, as it has often proved to be in a few years. This will be brought out in a very pronounced way if proper records of lost and unaccounted-for current are made each month.

A very forcible example of the rapid change in transformers can be cited in the writer's experience at the plant at Madison, where 460 kilowatts capacity of transformers was purchased under quite stringent specification about five years ago. At the time at which these transformers were purchased, they showed a remarkable record so far as high efficiency, close regulation and low core loss were concerned, but when put into service the depreciation was very high, in that the iron aged very rapidly, increasing the iron loss some 200 to 250 per cent. The insulation failed to withstand the test of time, to the extent that it was finally deemed advisable to dispose of the entire equipment as junk and substitute in its place more modern transformers which were constructed upon better engineering principles and this was done about a year ago.

This example only goes to show that it is necessary to allow a liberal percentage for depreciation to protect the station from being swamped by unexpected failure of apparatus.

LOST AND UNACCOUNTED-FOR CURRENT.

Lost and unaccounted-for current assumes such large proportions in some stations that radical measures have to be taken for its reduction.

The losses in different systems vary from a small per cent in small direct-current stations, to as much as fifty per cent of the station's output in some alternating-current stations where individual transformers are used.

The difference between the amount of electric energy sold and generated represents the loss between the switchboard and the consumer's meters.

The output is registered by the switchboard meters at the station, and the amount sold by the consumer's meter. Some of the losses which go to make up this difference are legitimate losses, and may be calculated for any system of distribution. The amount which remains after deducting these losses is termed "unaccounted-for current," and is usually made up of faulty registration, leakage and theft of current.

The power losses in alternating-current circuits may be divided as follows:

Transformer iron loss.

Transformer copper loss.

Resistance loss in primary transmission wires.

Resistance loss in secondary distribution wires.

Meter shunt loss.

Lost and unaccounted-for electric power.

The first three do not appear in direct-current system, but each of the losses will be considered separately with an endeavor to show how they may be calculated, and possibly reduced.

Each circuit should be considered by itself, taking into account the connected load on the circuit, the length of wire in primary and secondary circuit as well as the characteristics of the transformers, and the watts consumption per lamp per year, thereby offering a means of comparison, at the same time simplifying matters and facilitating the tracing of the losses.

TRANSFORMER LOSSES.

The transformer iron losses are figured by multiplying the iron losses per transformer by the number of transformers on the circuit and this by the number of hours in use.

All transformers should be tested both for iron and copper losses before being placed on the line, and a careful record kept of these tests, while a check on the iron losses should be made whenever a transformer is brought in, or if changes are infrequent, certain pilot transformers should be selected and periodic tests made upon them. If tests can not be made, approximate results may be obtained by assuming the losses as given by the manufacturers, but the latter is not recommended unless conditions absolutely prohibit the testing by the purchaser. When tests are made care should be exercised to see that the tests are made under running conditions, particularly with regard to voltage and frequency.

The transformer copper losses are figured by the use of previous tests made to ascertain the copper losses on each transformer on the line for one-fourth, one-half, three-fourths and full load.

These losses for all transformers on the line are added together and plotted in

a curve, using amperes of load as ordinates and watts as abscissæ. Then for each ampere reading taken on the circuit during the twenty-four hours' test run, the corresponding watts loss is found on the curve. These losses are added up for a period of twenty-four hours, and the loss for a month is found in the same way as the primary and secondary C^2R losses, as these copper losses are strictly resistance losses.

For Madison station the copper losses for twenty-four hours are very nearly equivalent to full-load copper loss for two hours, the balance of twenty-two hours being considered to be running at no load. This, of course, would vary somewhat with the ratio of transformer capacity to maximum demand.

RESISTANCE LOSSES.

In figuring primary resistance losses, knowing the size and length of the copper in the mains, the C^2R loss is figured by assuming one ampere to be flowing to a point where the circuit divides, and then assuming that the one ampere divides in proportion to the connected load on each respective branch. The sum of all these C^2R losses is taken as a constant for figuring the all day losses, which is done by taking the station ammeter readings at intervals of thirty minutes during light load and ten minutes during peak load. Each of these readings is then squared and multiplied by the constant, and afterward reduced to kilowatt-hours; by considering the time intervals of the readings, the sum of the results of these calculations represents the all day C^2R loss.

The station output for the period must be measured by the station wattmeter.

In order to obtain the monthly resistance loss in the primary circuit the monthly output, as shown by the station meter, is divided by the output during the test run multiplied by the number of days in the month. This figure is squared and multiplied by the resistance loss for that of a single day as determined by the test run, and then multiplied by the number of days; this will give the resistance losses as near as it is possible to calculate them practically, for the losses increase and decrease in proportion to the square of the increase or decrease of the output for the particular circuit under consideration.

The secondary resistance loss is figured in much the same way as is the primary, only it is necessary to use more judgment in the distribution of current in secondaries. The current distributed is determined and divided in proportion to the connected load, and the number of lamps in each block is counted and the number reduced to a basis of amperes, which gives the amount of which to figure the secondary losses.

Quite recently there has been placed upon the market an instrument designed by Mr. C. W. Humphrey, which is invaluable in determining the division of load on the several branches between transformers working on an interconnected secondary network.

The instrument consists of a small series transformer, the coil of which is placed on an iron ring, so arranged that a small segment of the ring can be opened and closed over the conductor carrying the current to be measured.

The transformer proper, which weighs about two pounds, is connected to sixty feet of flexible duplex cable, the free ends of the cable being fitted with terminals suitable for clamping in the binding-posts of a portable ammeter. The ammeter, which in reality is a milli-voltmeter properly graduated, reads direct the value of the current flowing in the conductor.

By means of this instrument a large system can be checked up in a single evening. One man takes the small coil to the top of the pole and snaps it successively onto the two outside wires of the three-wire secondaries leaving the transformer, and another man at the foot of the pole on the ground reads and records the load that each side is carrying.

By the use of this instrument it is shown that no matter how carefully an estimate may be made as to what the probable division of load will be, that gross errors will be found, one transformer carrying much more load than was intended for it, and one side of the system may be found overloaded, while the other will be found to be underloaded.

In connection with this method of keeping connected load records, a card system adapts itself admirably.

CARD SYSTEM FOR KEEPING RECORD OF CONNECTED LOAD.

At the Madison plant the first division is made up of the individual circuits—six in number—each circuit occupying one drawer of the card cabinet. Next, each circuit is divided according to the transformers connected on it, a pilot card being used for each transformer, there being but forty-three transformers in all for a connected load of 42,000 lamps. Under the head of each transformer appears a minor card for each street which makes up the district fed by the transformer's network of secondaries as far as the junction points between adjacent transformers, and numerically according to the house numbers are cards for each connection, or rather, each meter, as one connection may feed a number of meters. On the other card is given the installation of lamps, giving the number installed of each candle-power, also the equivalent number when reduced to a sixteen-candle-power basis, also showing whether the same are on No. 1 or No. 2 side of the secondary network. A cross index giving the name and street address is also kept for the purpose of easily locating any consumer.

Every lamp sent out is recorded, and once a month all changes in connected load are changed on the cards, and new consumers' cards are filled in at the proper place, and disconnections are removed, the removals being kept for future reference, should the same or another party apply for a connection at the same number.

A count is then made which shows the connected load upon the transformers, the connected load upon the circuit, the connected load upon the station, as well as the connected load on each side of each three-wire secondary network, which so frequently becomes entirely unbalanced if stringent means are not used to maintain the proper distribution of load between the two sides.

METER SHUNT LOSS.

The next loss to be considered is the meter shunt loss.

A record is kept of all meters sent out on each circuit, their make, size and type, and a record of their test, and from these data the meter shunt loss may be easily calculated for each month, a careful test having been made of a sufficient number of meters to obtain a constant for the shunt loss of each size and make and type of meter.

The average shunt loss for late type alternating-current lighting meters may be considered to be about two and one-half watts, and as the average loss is so small, one would naturally think that this loss could almost be neglected, but this is far from true; for instance. the station under consideration had one circuit where the meter shunt losses aggregated more than did the transformer core losses, being for a certain month 5.93 per cent of the output for meter shunt loss, and 5.01 per cent for transformer core loss, and in many cases these items will be found to be equal. In the case of T. R. W. type of meter, such as are used on most direct-current power circuits, considerable unaccounted-for current may be brought to

light by making it a rule to give the meter jewel a careful overhauling after each run, consisting of 400,000 turns of the shaft, which may easily be determined from the reading of the meter.

The lost and unaccounted-for current, besides arising from faulty registration, leakage and theft of current, may come from lost records. Few plants will find that a careful checking over of their circuits will not bring to light some consumers whose names are not upon the books.

After these data are collected for the several circuits it is an easy matter to determine where the trouble lies. Such information will show at a glance whether or not line losses are excessive, or core losses too high, or whether all transformers are properly loaded, and, in fact, will enable changes to be made so that the lines may be operated at the highest possible efficiency.

As an illustration a tabulation is given as worked out for the Madison plant for an October day.

Circuits.	Output.	Core Loss.	Per Cent.	Cpper Loss.	Per Cent.	Meter Shunt Loss.	Per Cent.	Primary C^2R Loss.	Per Cent.	Secondary C^2R.	Per Cent.	Total Loss.	Per Cent.
1..... ...	421,000	28,488	6.76	3,461	0.82	14,916	3.54	19,006	4.51	1,456	0.55	67,327	15.98
2.....	522,400	19,752	3.78	6,379	1.22	19,092	3.65	14,103	2.7	2,604	0.49	61,930	11.84
3.....	300,000	28,680	9.56	4,313	1.44	23,316	7.77	10,744	3.58	1,969	0.66	68,749	22.91
4.....	413,000	20,712	5.01	3,208	0.77	24,504	5.93	20,079	4.86	6,404	1.55	74,907	18.12
5.....	477,600	42,576	8.55	3,653	0.73	18,720	3.76	21,817	4.38	3,297	0.68	90,163	18.10
Total..2,134,000		140,208	6.51	21,014	0.97	100,548	4.67	85,749	3.98	15,830	0.72	363,076	16.85

The losses on the 500-volt power at the same station for the same time were as follows:

Output.	C^2R Loss.	Per Cent.	Meter Shunt Loss.	Per Cent.	Total.	Per Cent.
1,183,400	42,644	3.6	63,571	5.4	106,235	9

SELECTION OF INCANDESCENT LAMPS.

We come now to the question of the proper selection of incandescent lamps, which is a very important one to the central station manager. It is undesirable to have more than one voltage and more than one wattage of lamps in use, as they are sure to get exchanged and mixed up, increasing the cost of lamp renewals where the low-voltage lamp gets installed in place of the higher voltage and creating a just cause for complaint where the lamp is operated at a lower voltage than that for which it is designed.

Probably nine-tenths of our consumers, if left to purchase their own lamps, would buy a low-efficiency lamp that would burn 1,500 hours or more, without taking into consideration that fact that to secure the same candle-power they would be paying for about thirty per cent more current.

If the matter is left to the lamp salesman he will recommend high-efficiency lamps with the corresponding shorter life, because this will naturally increase the lamp sales in his territory.

The question of what efficiency lamp should be used is one which lends itself to a comparatively easy solution.

For its solution it is necessary to determine:

1. Average regulation on the circuit.
2. Generating costs, which are proportional to output.
3. The investment made per kilowatt capacity.
4. The average consumption per lamp per year.

To take an example.

For a 3.1-watt lamp burning 263 hours would consume 16 × 3.1, times 263, or 13,044.8-kilowatt hours, which, divided into seventeen cents and one and one-half cents, gives us the cost per kilowatt-hour for the lamps and for the labor of renewing them, or added together, a total cost per kilowatt-hour for lamp renewals.

Having determined that the regulation is maintained within three per cent, we find from standard lamp specifications, assuming that the first cost of the lamp is seventeen cents, and that the cost of photometering, handling and renewing costs one and one-half cents each, as follows:

Efficiency.	Life.	Lamp Cost in Cents per Kw.-Hour.	Cost of Renewing per Kw.-Hour in Cents.	Total Lamp Cost per Kw.-Hour in Cents.
3.1	263	1.30	0.114	1.414
3.5	492	0.618	0.054	0.672
4.0	910	0.29	0.026	0.316

As a simple proposition let it be considered that the plant is selling light to itself, which will bring the interest of the producer and consumer to a common ground in considering the best efficiency to be selected.

It must be considered that it is light which is being sold, and not kilowatt-hours, for it is light which the consumer wants, and other things being equal, he does not care whether he obtains that light through a 3.1-watt lamp or a four-watt lamp.

If light is being supplied through a 3.5-watt lamp, and a change is made to a four-watt lamp, the station will be called upon to increase its expense under two different heads.

In the first place it will have to increase its capacity throughout in direct proportion to the increased wattage of the lower efficiency lamp, which, in the case under consideration, will amount to an increase of 14.3 per cent.

The investment per lamp installed can be easily figured for any station knowing the total investment and the connected load, and in this case we will assume that the station investment is $10 per lamp, which will probably be a close average. If interest is taken at six per cent, and depreciation covering the general equipment is taken at six per cent, we have an additional cost per lamp of twelve per cent on the 14.3 per cent of the $10-per-lamp investment, or $0.1716 per lamp per year.

The station has a further expense in furnishing sixteen candle-power with the four-watt lamp over that of the 3.5-watt, in that it must furnish the additional 14.3 of the current which would be generated at the part of the manufacturing expense which is strictly proportional to output.

In this we have mainly to deal with boiler fuel and a part of boiler-room labor, for engine-room labor changes but a small amount in a medium sized station with a variation of load.

The repairs to engines and dynamos are somewhat dependent on output, but in a large plant they are fixed, the repairs being nearly as great if the apparatus is running delivering no current, as it is with a fair load.

The remaining items which come in under the head of generating costs are practically fixed with the small changes which would be introduced in substituting a lamp of one efficiency for that of another.

We will assume a total generating cost which is strictly proportional to output at two cents per kilowatt-hour. If the lamp were consuming twenty kilowatt-hours per lamp per year on a three and one-half-watt basis, the consumption would be increased 2.86 kilowatt-hours per lamp per year, if four-watt lamps were substituted, and this at the output cost of two cents per kilowatt-hour would amount to $0.0572 per lamp per year, which, together with the interest and depreciation on the additional investment of $0.1716 amounts to $0.2288 per lamp per year, which is balanced against the

difference in the cost of lamp renewals for the year.

The 3.5-watt lamp burns twenty kilowatts per lamp per year, so the lamp renewal cost on the 3.5-watt being 0.00672 per kilowatt-hour, would amount to $0.1344, and the four-watt lamp consuming 22.86 kilowatt-hours to furnish the same amount of light would, at its rate for lamp renewals of 0.00316 per kilowatt-hour, cost $0.0722 per year, or the three and one-half-watt lamp would cost $0.0622 per annum more for lamp renewals than would the four-watt, but the four-watt lamp would cost $0.2288 more per lamp per year for additional current and interest and depreciation on the additional investment, so that under the conditions assumed there would be a saving to the producer of $0.1666 per lamp per year by the use of the three and one-half-watt lamp, or for an installation such as the one under consideration, there would be a saving of $6,997.20 per annum on a connected load of 42,000 lamps.

The above is determined by assuming that the lamps are renewed at the end of their useful life, or at a time when they have fallen to eighty per cent of their original candle-power. The cost per kilowatt-hour will then be:

$$\text{COST OF LAMP.}$$

Efficiency $\times$ candle-power $\times$ useful life.

It is poor policy for a lighting company to allow old lamps to remain upon its lines after the same have fallen to eighty per cent of their original candle-power, as the illumination from such lamps can not help but be poor and unsatisfactory, and the consumer will have a just ground for complaint.

To prevent the existence of such a condition it is necessary for a company to make periodic wholesale lamp renewals wherein every lamp is taken out of every socket and good lamps placed in their stead. The lamps which are removed should then be cleaned and photometered, and all lamps which fall below ninety-five per cent of their original candle-power should be culled out as seconds, to be used in attics, garrets and cellars, while all falling below eighty per cent should be placed in the junk pile.

With a station having a very pronounced peak load for a very few weeks during the holiday season, a material saving may be found by the substitution of a high-efficiency lamp for the short interval of time during which the peak load lasts. For instance, at Madison, just previous to the holiday season, there are about three weeks when the peak load on the commercial districts overlaps the peak load on the University districts so that the combined peak is very high and sharp, and lasting but a few weeks out of the year, it is very narrow when plotted with months of the year as abscissa.

Suppose the station is fully loaded, so that any additional load will require additional generating and distributing equipment; it is perfectly proper, then, to credit on one side of the balance the interest and depreciation of the investment which will be saved by the substitution of 3.1-watt for a 3.5-watt lamp, for with the same equipment of station and line it will be possible to furnish current for 11.4 per cent more lamps, and against this must be charged, on the other hand, the additional expense which will be incurred by the increased lamp renewals of the higher efficiency lamp and the cost of making the changes.

As shown above, with a three-per-cent regulation, the 3.1-watt lamp gives a life of 263 hours, against 492 hours for the 3.5-watt, or there is a loss of lamp life of 229 hours per lamp for each substitution so made, and where the 42,000 lamps are exchanged, this means a loss of 9,618,000 lamp hours of lamp life, and as lamp renewal costs are made up of the cost of the lamp plus the labor changing and photometering, the cost of per lamp-hour would equal

$$\frac{17 - 1.5}{492} \text{ equals } \$0.0037 \text{ for}$$

renewing alone, and having lost 9,618,000 lamp hours by this change, the expense incurred, due to additional lamp renewals, would amount to $3,558.66 provided all of the useful life of each lamp was used up, or the lamps each burned 263 hours.

During this month the actual burning of each lamp averaged about forty-five hours, so instead of having expense of $3,558.66 for the increased lamp renewals which would be occasioned should all the lamps burn 263 hours, the expense would be

$$\frac{45}{263} \text{ equals } 17.1 \text{ per cent of } \$3{,}558.66,$$

$$\text{or } \$622.76,$$

and to bank against this expense there would be saved the interest and depreciation at twelve per cent on 11.4 per cent of 42,000 lamps at an investment of $10 per lamp, or $5,745.60, or by such a substitution a saving of $5,122.84 would be effected per annum.

Another factor should come into consideration at this point, and that is that the consumer is using a smaller amount of energy for a given amount of illumination during this short period, and he is benefited during this time by having a decreased bill, to which he will not object, while the station will have its kilowatt-hour sales curtailed by an amount equal to the difference in lamp efficiency, provided the consumer is paying for his current on a straight meter rate.

It is very essential, in following out any of the analyses, to know positively that the data at hand are thoroughly reliable, for without such knowledge nothing can be accomplished; but a careful analysis of these several distribution problems, followed by a practical application of the remedies as set forth, will very frequently bring about such a radical change in the economical working of a plant that the net earnings, which may before have appeared as a minus quantity, will now appear in a substantial way as a positive profit.

Legislation for the Milan, Italy, Exhibition.

The executive committee, for the purpose of better attaining the object of uniting at the Milan Exhibition all the improvements which have been made in the artistic as well as the industrial field, has brought to the notice of the Italian Minister of Agriculture, Industry and Commerce, the necessity of formulating special legislative provisions (as has been done before in the case of all previous international exhibitions) to give protection to everything that will be sent to the exhibition from abroad.

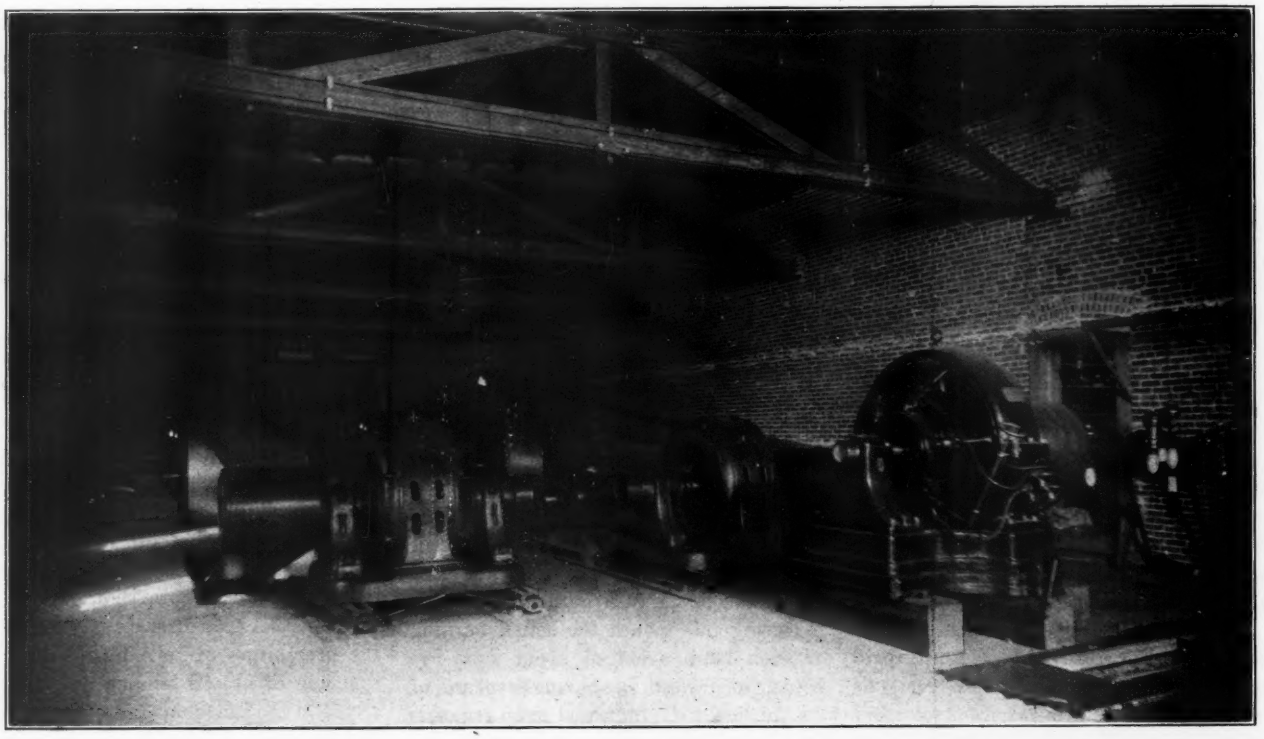
The legal provisions invoked contemplate the derogation of the articles 50, 64 and 68 of the law on Italian patent rights, etc. These provisions should for the objects exposed, suspend first of all the prohibition of introduction into the kingdom of objects similar to those protected in the kingdom, and limit the right to sequester infringements or articles bearing forbidden marks to the sole cases in which the person who provokes the sequestration holds the rights in the same country as the person who is to suffer the sequestration.

Further, it should be sought to stimulate the showing of new inventions in the exhibition to the promotion and utilization of inventions, and interrupt the expiration of patents, etc. Lastly, to the states who do not belong to the international convention on industrial rights there should be extended a protection to patentable objects exposed.

The Minister of Agriculture, Industry and Commerce has replied that this serious matter has already been taken into consideration.

The Gas and Electric Plant at Muskogee, I. T.

AN INTERESTING gas and electric and ice plant installation has recently been completed by H. M. Byllesby & Company, as engineers and managers, at Muskogee, I. T., the headquarters of the Dawes Indian commission and the residential headquarters of the government officers in charge of the various Indian tribes. The present population is approximately 15,000. The city has been the subject of a rapid growth, the population a year ago being 11,000, and four years ago, about 5,000. The surrounding country raises wheat, corn, cotton and ordinary farm products. An oil field was discovered immediately outside of the city about a year ago, and is now a large producer of a high-class oil. An oil refinery is being erected. The main streets of the city are being paved, and every effort is being made to make the town comfortable and modern in every respect. There are five steam railroads entering the city, and it is fast becoming an important jobbing and distributing centre. The usual line of minor manufacturing interests is situated there, including a cottonseed oil mill, cotton gin and several machine shops. The residential buildings are of handsome design, and there have been erected a number of elaborate brick and stone office buildings and mercantile establishments. The city has four boarding schools and colleges, these being largely connected with the Indian reservation. It is anticipated that the town will continue its growth to a population of approximately 50,000 people. It is geographically well located, and with the coming admission to statehood of Indian Territory, a greater increase in growth is expected. This will be largely influenced by the settling of the question of Indian titles. At the present time it is extremely difficult to obtain a legal title to property, owing to the governmental restrictions concerning Indian lands.



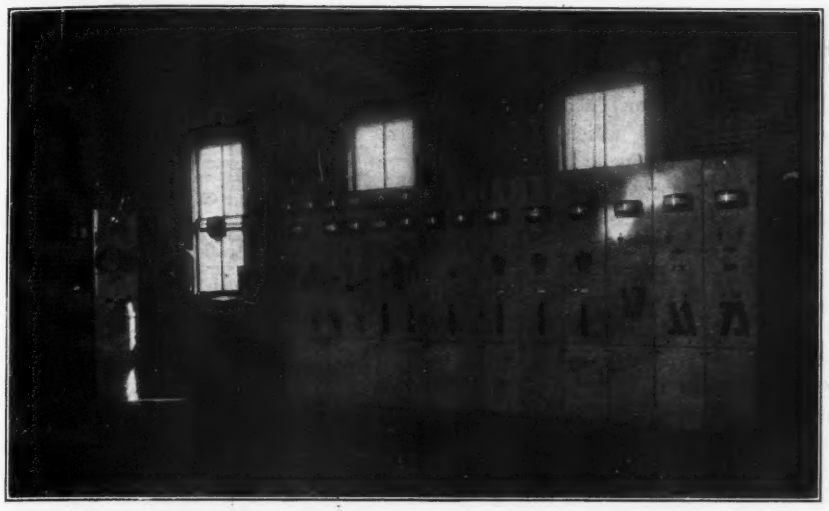
INTERIOR OF DYNAMO ROOM, GAS AND ELECTRIC PLANT, AT MUSKOGEE, I. T.

Prior to March 1, 1904, the electric lighting and gas plant was owned by citizens of Muskogee. At that time the present company purchased the plant, and has since made large additions to keep pace with the growth of the town, the reconstruction of the ice and electric plant having been finished in December, 1903. A new gas plant is now approaching completion. All of the buildings are substantial brick structures.

The electrical equipment consists of two General Electric three-phase alternators of 200-kilowatts capacity each, two St. Louis Corliss engines, two Babcock & Wilcox boilers, a General Incandescent Arc Light Company marble switchboard, and a General Electric enclosed alternating system for street lighting.

The ice plant has a total capacity of thirty-five tons per day, with duplicate compressors. The gas plant is on the modern high-pressure system. The gas is manufactured from coal, exactly as in the old-fashioned method, and is delivered to a low-pressure holder. From the low-pressure holder it is passed through duplicate compressors and compressed to twenty pounds per square inch, and is then passed into a high-pressure holder. From this it is distributed through wrought-iron mains to the consumers' premises. Each consumer's equipment, in addition to the meter, is furnished with a reducing valve for lowering the pressure. The gas plant has twelve miles of mains. The telescopic holder has a capacity of 30,000 cubic feet. The gas plant contains two benches of sixes and a spare arc built by the Missouri Fire Brick Company. The purifying and scrubbing apparatus and the holder were built by the Stacey Manufacturing Company, Cincinnati, Ohio.

At the present time there are over 450 consumers connected by electric meters. There is a rated capacity of 375 horsepower in motors connected to the electric system, and with the completion of the

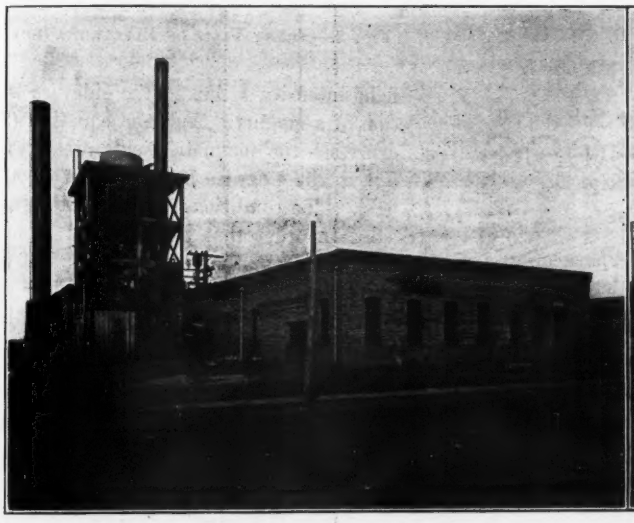


SWITCHBOARD, GAS AND ELECTRIC PLANT, AT MUSKOGEE, I. T.

gas plant there will be connected approximately 600 consumers, principally for fuel gas.

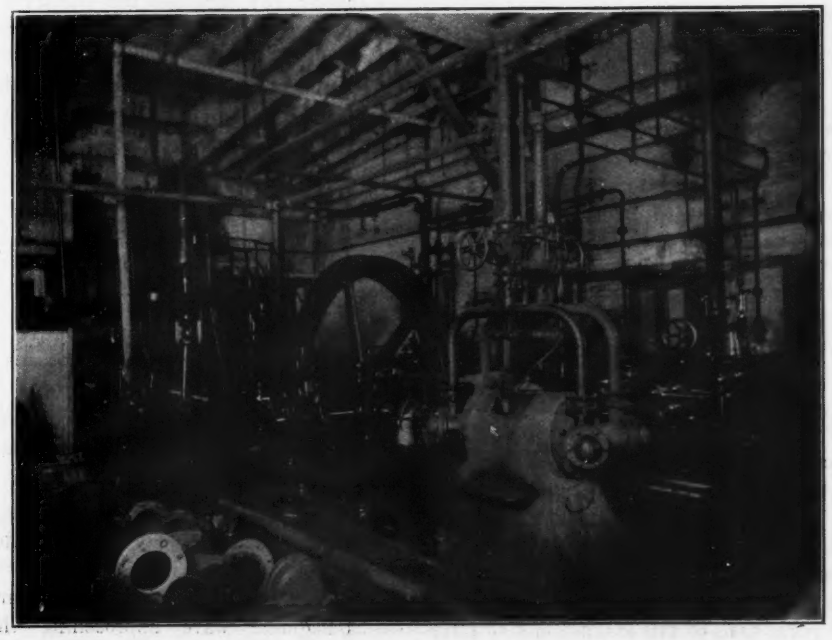
A street railroad is being built in the town, with about three miles of track. The electric and gas company furnishes current for this system on a meter basis. The railway generator has a capacity of 100 kilowatts, and was furnished by the Fort Wayne Electric Works, Fort Wayne, Ind. The car equipment for the railway system is of General Electric manufacture. H. M. Byllesby & Company are also engineers for the street railway system.

The company has a city contract which runs for a period of five years, at ninety-six dollars per lamp per year. At the present time there are only fifty-four of these lamps connected up.



EXTERIOR OF ICE AND ELECTRIC PLANT, MUSKOGEE, I. T.

GAS PLANT AT MUSKOGEE, I. T.



INTERIOR OF ICE PLANT, GAS AND ELECTRIC PLANT, AT MUSKOGEE, I. T.

During the year ending March 1, 1904, under the former ownership the plant made a profit of $12,000 net. In the ten months from March 1, 1904, to January 1, 1905, a profit of $21,938.47 was made.

The officers of the company are as follows: president, B. R. Burroughs, Edwardsville, Ill.; vice-president, L. D. Turner, Sr., Belleville, Ill.; secretary, L. D. Turner, Belleville, Ill.; treasurer, W. N. Warnock, Edwardsville, Ill. The directors are R. D. W. Holder, Belleville, Ill.; Clarence W. Turner, Muskogee, I. T., and M. M. Stephens, East St. Louis, Ill.

The Cleveland Electric Railway Company, of Cleveland, Ohio, has abandoned the system of three-cent fares for a ride of two miles from the centre of the city, which was instituted some time ago. The plan was not popular with the public, and was unprofitable to the company. A new plan has been put in operation, by which a passenger may ride the full distance on one line for four cents. To obtain a transfer a five-cent fare must be paid.

WAVE DISTORTION ON TRANSMISSION LINES.[1]

BY WILLIAM S. FRANKLIN.

The first part of the lecture was devoted to the development of the mechanical conceptions of electromagnetic action. The object of this introductory part of the lecture was to furnish a concrete basis, a model as it were, for the discussion of electric waves and wave distortion.

These mechanical conceptions are due to Maxwell and they have been discussed in a popular way by Lodge in his "Modern Views of Electricity." The best exposition of these conceptions is to be found in chapter xv, vol. ii, second edition, Nichols and Franklin's "Elements of Physics." The student who wishes to familiarize himself with these conceptions should read Lodge as an introduction, then read Nichols and Franklin's discussion.

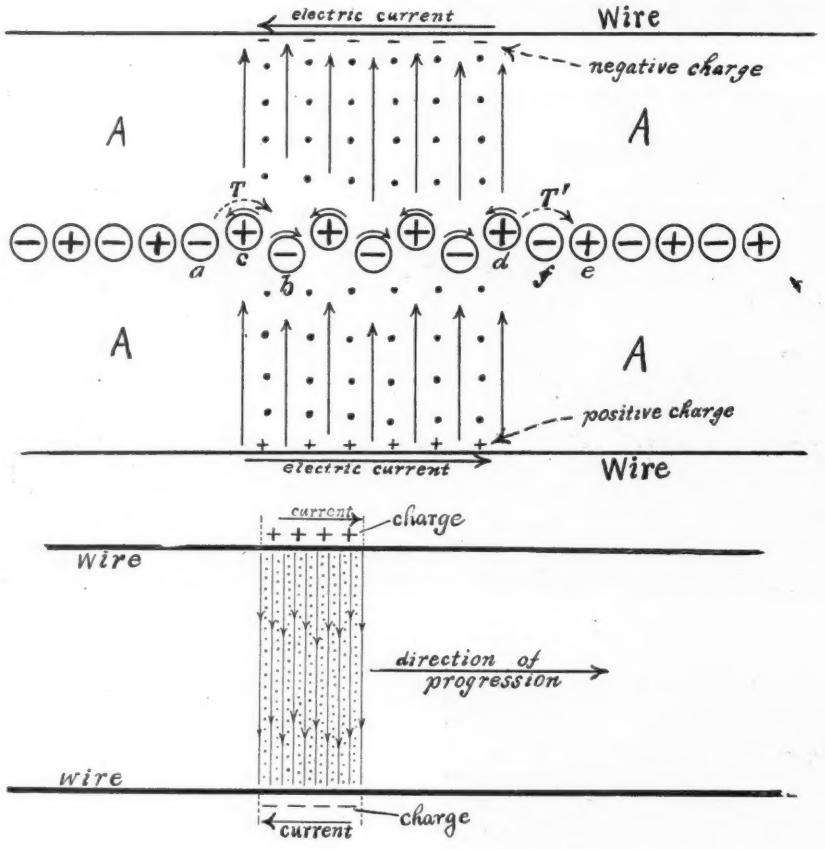


FIG. 1.—INTERDEPENDENCE OF ELECTRIC AND MAGNETIC FIELD, SHOWN BY MAXWELL'S MODEL.

A wave over the surface of water consists of an elevation or depression and a localized state of acceleration of the water particles both of which move along together, and the unbalanced forces associated with the elevation or depression are the forces which produce the accelerations which accompany the wave.

An electric wave consists of an electric field (ether distortion) and a magnetic field (ether motion) which move along together, the magnetic field being due to the electric field and the electric field being due to the magnetic field. This state of affairs is shown in Fig. 1 in terms of Maxwell's mechanical model.

The mutual dependence of the electric and magnetic fields, which together constitute an electromotive wave, may be formulated as follows: (1) a wire of length l moving sidewise at velocity v across a magnetic field of intensity H has induced in it an electromotive force $E = l\,H\,v$. Now $E \div l$ is the electric field intensity e parallel to the wire, this electric field is the physical basis of the electromotive force, and, in general, instead of H we should use flux density μH so that

$$e = \mu\,H\,v \qquad (1)$$

(2) An iron wire of length l moving at velocity v across an electric field of intensity e has a magnetomotive force equal to $l\,e\,v$ $(= l\,H)$ produced along it, and the physical basis of this magnetomotive force is a magnetic field of intensity H parallel to the iron wire and due to its motion across the electrical field; but instead of e we should in general use electric flux density $k\,e$, where k is the inductivity of the medium, so that

$$H = k\,e\,v \qquad (2)$$

Equation (1) expresses the electric field intensity e due to the sidewise motion of a magnetic field, and equation (2) expresses the magnetic field intensity H due to the sidewise motion of an electric field. The conditions which must be satisfied in order that the whole of H may be produced by the motion of e and at the same time the whole of e produced by the motion of H may be found by treating equations (1) and (2) as simultaneous equations which give at once

$$v = \frac{1}{\sqrt{\mu\,k}} \qquad (3)$$

and

$$\frac{1}{2}\,\mu\,H^2 = \frac{1}{2}\,k\,e^2 \qquad (4)$$

Equation (3) expresses the velocity at which H and e must move sidewise so as to be mutually dependent on each other. This is the velocity of an electromagnetic wave. Equation (4) expresses the further condition, that in a so-called pure electromagnetic wave the magnetic energy is everywhere and always equal to the electric energy.

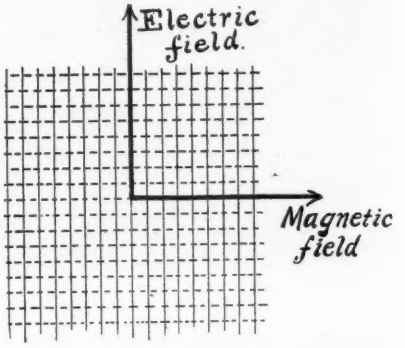


FIG. 2.—FRONT VIEW OF ELECTROMAGNETIC WAVE.

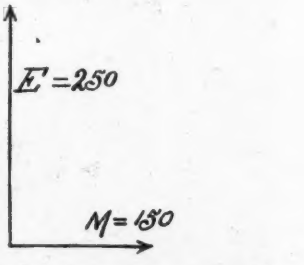


FIG. 3.—ELECTROMAGNETIC FIELD WITH MAGNETIC FIELD REDUCED.

Fig. 2 represents a front view of a pure electromagnetic wave approaching the reader. The full lines represent electric

[1] Abstract of a lecture delivered before the New York Electrical Society on Wednesday evening, January 18, 1905.

field and the dotted lines represent magnetic field.

One may see from Fig. 1 that the angular velocity of the ether cells (magnetic field) is diminished continually by the

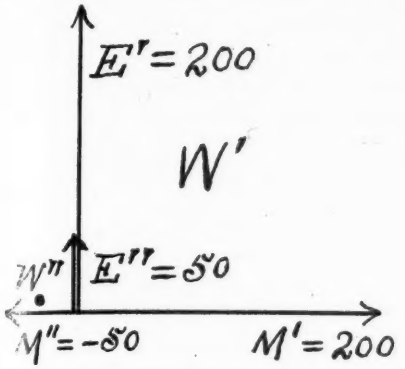


FIG. 4.—REPRESENTATION OF TWO OPPOSITELY MOVING WAVES.

friction of the rotating cells (resistance of wires) which are next the wires at upper and lower limits of the wave. In fact, the effect of line resistance is primarily to cause a decrease of the magnetic

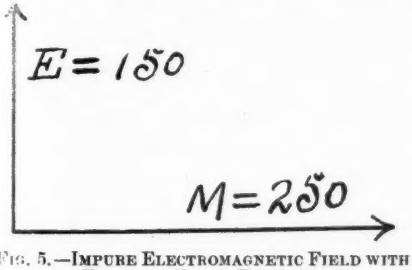


FIG. 5.—IMPURE ELECTROMAGNETIC FIELD WITH ELECTRIC FIELD REDUCED.

field in an advancing electric wave without affecting directly the electric field. On the other hand, if the structure of the medium in the region occupied by the wave gives continuously to the stress

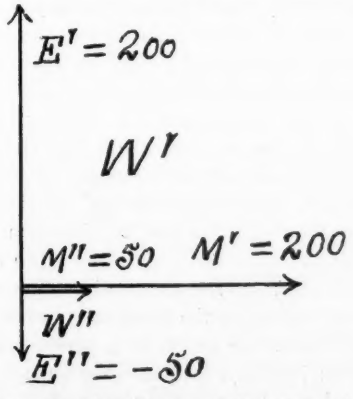


FIG. 6.—REPRESENTATION OF TWO OPPOSITELY MOVING PURE WAVES.

which is represented by the zig-zag chain of ether cells in Fig. 1, this ether stress would continue to decrease in value as the wave advances. In fact, the effect of imperfect insulating property of the material between the two wires of a transmission line is primarily to cause a decrease of the electric field in an advancing electric wave without affecting directly the magnetic field.

The distortion of an electric wave pulse as it travels along a transmission line is due wholly to the fact that line resistance reduces the magnetic field only and that poor insulation reduces electric field only. A detailed description of wave distortion depends upon the conception of an impure electromagnetic wave.

Fig. 3 represents an electromagnetic wave in which the magnetic field has been reduced from its original value of 250 units to 150 units by the effect of line resistance. If E and M in Fig. 3 were moving together at velocity v $\left(=\frac{1}{\sqrt{\mu k}}\right)$, E would produce more than 150 units of M and 150 units of M would not produce the full value of E. That is to say, a wave like Fig. 3 is not a simple progressing wave. What Fig. 3 is, however, is shown in Fig. 4, which shows two oppositely moving pure waves which are together equivalent to Fig. 3, and Fig. 3 represents what is called an impure electromagnetic wave. Fig. 5 represents an impure electromagnetic wave in which the electric field has been reduced from its original value of 250 units to 150 units by the effect of poor line insulation, and Fig. 6 shows two oppositely moving pure waves which are together equivalent to Fig. 5. This resolution of an impure wave seems a mathematical fiction, but it actually takes place. The physical process involved may be best understood by considering only the excess of M or E; that is, by considering a layer of magnetic field alone or electric field alone. The reader who is fairly familiar with the mechanical actions assumed to take place in the hypothetical cellular ether (see Fig. 1) will readily see how such a layer breaks up into two equal and oppositely moving pure waves.

Before describing the actual process of distortion, it is necessary to adopt a scheme for representing an electromagnetic wave pulse graphically. Such a representation is indicated in the rectangular curve in the lower half of Fig. 7. This curve

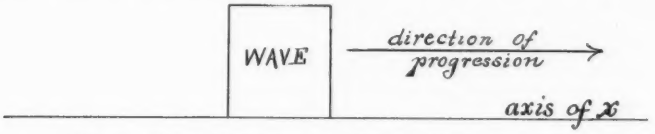


FIG. 7.—REPRESENTATION OF ELECTROMAGNETIC WAVE IMPULSE.

represents the wave shown in the upper half of the figure.

The black rectangle A, Fig. 8, represents a pure electromagnetic wave which at a given instant is supposed to be called into existence out on an indefinitely long pair of wires. As this wave proceeds its magnetic field is decreased by line resistance (or its electric field by line leakage) and the wave becomes impure. The result is, as explained above in connection with Figs. 3 to 6, that a portion of the original energy in this wave begins to shoot backward as a reflected wave; a portion of the original wave being thus reflected at every point along the wire. This reflected wave, which in its turn is, of course, partially reflected at every point as it travels backward, generates what Heaviside calls the tail of the wave. The form of the wave after t seconds is shown

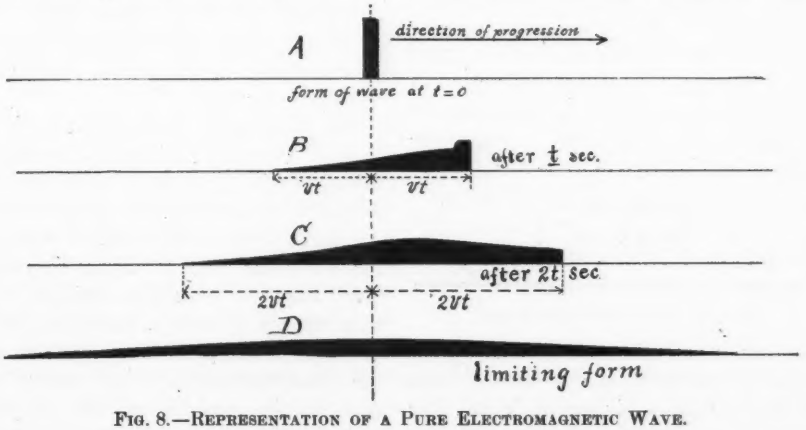


FIG. 8.—REPRESENTATION OF A PURE ELECTROMAGNETIC WAVE.

by B. The head of the wave has been considerably reduced (in values of E and M), and the tail reaches to a distance $v\,t$ back of the original position of the wave. The form of the wave after $2\,t$ seconds is shown by C and the final limiting form

of the wave is shown by D. The fatness of the tail is somewhat exaggerated in Fig. 8.

The distortion of a wave due to line leakage is in a certain sense opposite to that due to line resistance, inasmuch as the first is due to a decrease of E, and the second is due to a decrease of M. If line resistance and line leakage are so proportioned as to decrease E and M equally, then the wave will remain pure, no portion of the wave will shoot backward and the wave will not be distorted. A circuit in which line resistance and line leakage are related so as to produce this result is called the distortionless circuit by Heaviside.

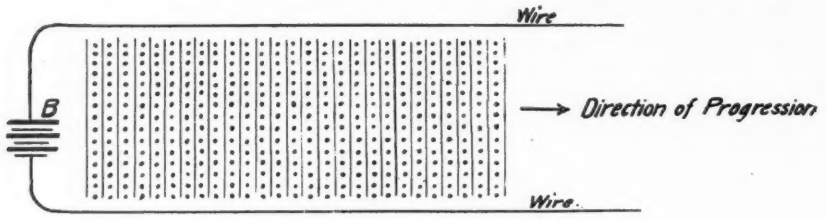


FIG. 9.—SPECIAL CASE.

The effect of resistance is always much larger than the effect of leakage on ordinary telephone lines and even on cables,

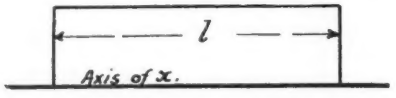


FIG. 10.—RECTANGULAR WAVE.

and therefore an increase of leakage reduces the distortion.

The effect of increasing leakage to the point necessary to give distortionless transmission is, of course, first to eliminate all distortion and the effect is furthermore to slightly affect the energy dissipated in transmission (counting only energy in the head of the wave pulse) as follows: suppose a wave having originally E = 250 and M = 250 is reduced by line resistance to E = 250 and M = 150. The unsustained electric field, that is the part of

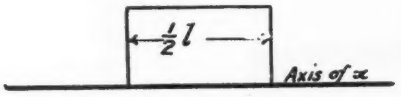


FIG. 11.—RECTANGULAR WAVE.

E which is not held up as it were by the sidewise motion of M (= 150), breaks up into two oppositely moving waves. The result is that all the energy represented by the reduction of M from 250 to 150 is lost as heat in the line wires, whereas half of the energy which is represented by the excess of E is thrown back into the tail and half goes forward as a newly created wave. Therefore, where the head of the wave arrives at the distant end of the line it has lost one and one-half times as much energy as is accounted for by the R i^2 loss in the line. Now if leakage is introduced so as to compensate for the distorting action of line resistance then all the energy due to the R i^2 loss shows itself as a reduction of M and an equal loss of energy is associated with the equal decrease of E by line leakage, so that when the head of a wave would arrive at the distant end of the line it will have lost energy to the amount of 2 R i^2 t instead of 1½ R i^2 t when leakage is zero.

The use of increased inductance for decreasing wave distortion and for decreasing the loss of energy in the head of a wave pulse while traveling over a given line may be shown in a very simple and elementary way as follows:

In the first place equations (3) and (4) may be written

$$v = \frac{1}{\sqrt{L\,C}} \qquad (5)$$

$$\frac{1}{2}\,L\,i^2 = \frac{1}{2}CE^2 \qquad (6)$$

in which L is the inductance of the transmission line per unit length, C is its capacity per unit length, i is the current flowing outward in one line and backward in the other at a given point on the line, and E is the electromotive force between the lines at the given point. The derivation of (5) and (6) from (3) and (4) need not be considered, although it is simple.

Let us consider a special case for the sake of clearness. Suppose a battery of electromotive force E is suddenly connected to the sending end of the line and a moment later disconnected. A rectangular wave like Fig. 10 would be started along the line. This wave contains a certain amount of energy, a certain portion of which is dissipated along the line, and the remainder arrives in the head of the wave at the receiving station. Suppose now that L is quadrupled, C and E being kept unchanged for the sake of comparison. Then from equation (5) v would be halved and i would be halved. If the sending battery is connected to the line for the same length of time as before, a rectangular wave of length one-half 1 will be started along the line as shown in Fig. 11, inasmuch as v is halved. Now current flows in the line wires only where the wires bound the wave, that is in length l of the double line in the first case and in length one-half l of the double line in the second case. Furthermore, the time required for the wave to reach the distant end of the line is twice as great in the second case. Therefore R i^2 t, or the total energy dissipated in the wires from the head of the wave, is one-quarter as great in the second case as in the first, since R is halved, i^2 is quartered, and t is doubled. But the total energy in the wave is half as great in the second case as in the first case, since l is halved and the energy per unit length is unchanged. $\left(\frac{1}{2}\,L\,i^2 + \frac{1}{2}\,CE^2\right)$. Therefore the percentage loss of energy from the head of a wave is halved by quadrupling the line inductance.

It must be remembered that equations (4) and (6) apply to pure waves only. As applied to pure waves these equations indicate that for a given line there is a fixed relation between voltage and current, neither can be changed without changing the other, or without changing the line constants. Furthermore, these equations indicate that voltage and current are always exactly in phase with each other in pure wave transmission. On the other hand, when reflected waves merge into the advancing waves on a line we no longer have pure wave transmission, and the relation between voltage and current, both as to relative values and as to their phases, depends upon conditions external to the line itself.

The limitation of the discussion to the wave pulse was deemed advisable by the lecturer for two reasons, *viz:* (*a*) the theory of distortion may be completely covered by a consideration of the behavior of a wave pulse, and (*b*) the physics of wave motion in a medium involving reactions, which in optics gives rise to absorption and dispersion and in electric transmission gives rise to distortion and attenuation, is vastly simpler for the wave pulse than for the wave train. The wave train represents the steady state of a system under the action of a periodic force which has been kept up long enough for the system to settle down to steady motion, and this steady state depends upon what is taking place at every point in the system, whereas the wave pulse, the head at any rate, has to do only with what takes place at one single point in the system.

The reader should keep in mind the fact that all of the discussion as outlined

above is based first upon the determination of electromotive force, and current relations on the assumption that line resistance and line leakage are zero, and then a consideration of line resistance and line leakage as disturbing effects.

The writer may be permitted to state that it is entirely misleading to the learner to dwell upon the limitations of Maxwell's cellular theory of the ether. There is scarcely a phenomenon of electromagnetic action which is not very greatly simplified by the use of these conceptions. The choice is between the use of differential equations, not for final integral solutions, but for descriptive purposes as it were, or the use of mechanical conceptions. In fact every phase of the foregoing discussion might be easily expressed in differential notation. It is, however, needless to say that such mode of expression would be to a great extent ineffectual. The difficulty with the ordinary mechanical notions which are so fundamentally fixed in electricians' minds, as evidenced by the very terms current, resistance and electromotive force, is that they do not give any insight into electromagnetic action, and the difficulty with the cellular theory, aside from the unmentionable one mentioned by Poynting, namely, that it fails in three dimensions!! is perhaps that it may never give any insight into the phenomena of moving electrons. My advice to the younger readers is to swallow Maxwell's cellular theory and digest it and do not turn away from it in disgust because some one says, truly, that it does not contain the secret of the universe.

In the discussion which followed the reading of this paper, Dr. M. I. Pupin complimented Dr. Franklin upon the great value and interesting nature of his paper. He said, however, that it was too much to expect an electrician to get any grasp of the subject in a short time. Dr. Franklin, he said, had been talking about electrical phenomena from alpha to omega in one lecture. It took four years of undergraduate teaching and two more years of post-graduate work to cover the subject. If the student, after six years, received a mark of six he was good; if he received a mark of eight he was very bright. He suggested that the use of mechanical devices illustrating electrical wave propagation should be dealt with carefully, because the student found it extremely difficult to reconcile electrical phenomena with mechanical analogies. He was glad, however, that Professor Franklin had called attention to mechanical models. They can neither be appreciated nor understood at once, but they form a basis upon which much investigation and study can be built, and lead eventually to much clearer concepts of the phenomena under discussion.

Mr. C. O. Mailloux considered that the use of the mechanical model was of the greatest advantage. While the subject presented by Dr. Franklin was undoubtedly a very complex one, requiring many years of study, he thought that he had succeeded in conveying his ideas very clearly and by relatively simple means.

ACCURACY CHECKS OF SWITCHBOARD INSTRUMENTS.

BY CLAYTON H. SHARP.

It is a matter of great importance in central station operation that the instruments on the switchboard should indicate accurately. Inaccurate instruments lead not only to unsatisfactory operation, but also to incorrect results in the central station bookkeeping. It is manifestly impossible to determine the exact conditions under which the station is running if the instruments used are not correct. Without an accurate knowledge of conditions, it is difficult to make betterments and impossible to determine when the station is operated in the most economical manner. It is particularly important that the central station voltmeters should be correct. If these read low, the incandescent lamps on the lines are burned at too high an efficiency and do not give a satisfactory life. If the voltmeters read high, the candle-power and efficiency of the lamps are low and the result is unsatisfactory to the consumer of electric current. It is of course quite unnecessary that the switchboard instrument should possess the same degree of accuracy and refinement that standard instruments do, but it is unfortunately impossible to rely upon switchboard instruments to maintain permanently even the required degree of accuracy for proper operation.

Switchboard instruments are liable to changes in their calibration due either to mechanical or to electrical and magnetic derangements. Of these the former are less insidious, since they can usually be detected by inspection, while the latter can not. Mechanical derangements may be due to friction either of the pivot on its jewel, of the moving part against particles of dust, or of iron in the air-gap, or of the pointer on fixed parts of the instrument. In view of the very small total moving force in an instrument, considerable errors may be introduced by a very minute friction. Starting with a moving force which is small in itself, an error of one per cent, say, corresponds to an increase of only one per cent in the restraining force which opposes the moving force and is equal to it. A retardation of this amount may easily be introduced by the pointer brushing over a little fur raised on the paper scale, by a roughening of the jewel or pivot, or in other ways. When this trouble occurs, it may usually be detected by irregularities in the movement of the pointer; that is, it sticks in certain places.

A further derangement is due to bent pointers. This is detected by noting that the instrument does not register correctly on zero. It is to be noted, however, that an incorrect zero indication may be due to other causes than a bent pointer. Derangement of the controlling springs may also produce this effect. The result of a bent pointer is that the instrument indicates uniformly high or low over the entire scale.

A further mechanical derangement is that caused by changes in the controlling springs. These may be weakened or displaced so as to make the instrument inaccurate. Such troubles can not usually be detected by inspection unless they are of a very aggravated nature, such as when two turns of a spring become interlocked.

Electrical and magnetic derangements to which instruments are liable are also of several kinds. It is not unusual for short-circuits and high-resistance breaks to occur in the fine wire of voltmeters and wattmeters. When such an accident happens in the auxiliary resistance, the effect of it is a short-circuit, to make the instrument read high, and effect of breaks is just the opposite. Changes in the value of the auxiliary resistance may occur through overheating, etc., and so the accuracy of the instrument may be impaired. Unless such changes are relatively very large, their presence can not be detected by inspection. Only an accurate check of the calibration of the instrument serves to determine their occurrence.

Of similar nature are the errors induced by changes in the permanent magnets. These are always in the direction of a weakened field. In case where the permanent magnet is used to furnish the field for a moving coil, direct-current, indicating instrument, this results in the instrument reading uniformly low over its entire scale, while the zero reading is unchanged. Where the magnets are used for braking motor meters, a derangement of this sort causes the meter to run fast. Magnets may be weakened by mechanical shock or by the influence of demagnetizing fields due to other magnets or to powerful currents in the vicinity.

There is another class of causes of incorrect readings which can not be classed as derangements, being either inherent in the instruments or due to outside influences. The most prominent of these is the effect of temperature. The best modern instruments are but little influenced by temperature changes within ordinary limits. Switchboard instruments are sometimes set up where temperature conditions

are abnormal, and their influence may be quite perceptible.

More important in its effects on the indications of instruments, particularly alternating-current instruments and those containing soft iron, is the influence of stray magnetic fields. Large feeders and bus-bars carrying heavy currents in the vicinity of the instruments may cause very large errors in their indications. Alternating-current instruments are affected most strongly, but even in the case of permanent magnet instruments these errors may amount to several per cent. Errors due to this cause can be located only by checking the instrument in position under working conditions. In making such a check it is of the utmost importance to use an instrument which either on account of its position or of its construction is uninfluenced by the stray fields which are giving the trouble.

Instruments, particularly those having a feeble controlling force, may go wrong on account of a static charge on the glass cover. The attractive force between such a charge and the pointer may exert a relatively large torque. Electrostatic instruments are particularly liable to this source of error. The trouble may be removed by grounding the entire surface of the glass, as by breathing on it.

Changes in the frequency of the supply current may also produce measurable errors in some types of alternating-current instruments. Such instruments need to be checked on current of the same frequency as that with which they are to be used. The form of the alternating-current wave is also a factor in some cases, making it necessary to carry out checks on the identical current with which this instrument is to be used.

In view of the many possible causes of errors in switchboard instruments and the impossibility of detecting these errors by other than electrical means, the necessity for periodic checking of these instruments becomes manifest.

The results of a check are for many purposes best expressed in the form of a correction curve to the instrument. A curve of this sort shows the amount of the correction, plus or minus, which must be added to the indications of the instrument at different points throughout the scale, in order that the true volts, amperes or watts may be determined therefrom. The amount of the correction will, in general, be different in different parts of the scale, due either to irregularities in calibrating the scale or to subsequent changes. An instrument furnished with an accurate correction curve becomes doubly valuable, since the true values desired are so readily obtained from the indications of the instrument. The form of such a calibration curve will, in general, not change unless the instrument is subject to outside disturbances or to inside friction. Electrical and mechanical changes and changes in the elasticity of springs may raise or lower the correction curve as a whole, but will not change its form. Correction curves for switchboard instruments, one for an ammeter and one for a voltmeter, are shown in Fig. 1.

In the case of instruments which are not too heavy and bulky, and which are so placed as that their accuracy is not impaired by outside causes, the instrument may be removed from the switchboard and taken to a laboratory for check. The Electrical Testing Laboratories, New York city, have made very complete and reliable arrangements for making checks not only of switchboard instruments, but of the finest standard instruments as well. The standardizing laboratory of the company is equipped with a very extensive series of the most accurate standards and of the best secondary apparatus to be used therewith. In laying out this equipment the endeavor has been made to arrange everything so that checks of instruments can be made with a minimum expenditure of time, and consequently at minimum cost. All measurements of electromotive force, current strength and power are founded on standardization made against standard cells and standard resistances; the potentiometer method being used. For checking direct-current voltmeters, ammeters and wattmeters to a moderate degree of precision, such as is required for central station instruments, Weston laboratory standard voltmeters and millivoltmeters with shunts are used as secondary standards. These instruments have been carefully checked throughout their scale against the standard cells and the standard resistances. They are kept in a fixed position and their constancy determined by frequent rechecks against the primary standards.

Alternating-current voltmeters are checked either on direct or on alternating current at the required frequency by comparison with a Weston laboratory standard alternating-current voltmeter which has been calibrated on alternating current of various frequencies, using a reflecting electrostatic voltmeter as a transfer instrument. Another standard instrument which is used for this purpose is a Hartmann & Braun reflecting astatic alternating-current voltmeter, which also has been carefully checked.

Alternating current of any frequency required is generated in the laboratory, the alternator being driven by a motor on a storage battery circuit. In this way very steady alternating-current pressure for purposes of checking is obtained. Alternating-current ammeters are checked on alternating current of the required frequency against either a Kelvin balance of the proper range or a Hartmann & Braun astatic alternating-current ammeter which has been carefully checked against primary standards. Very heavy alternating currents are available, so that ammeters of large capacity can be checked. By the use of this apparatus it is easy to measure exactly the ratio of transformation of current transformers used in connection with high-tension transmission lines. It is quite as important to know the ratio of transformation of the current transformer exactly as it is to know the error of the instrument which is used on its secondary side. This quantity can be determined once for all with the various loads of the transformer, and being known, the instrument which is used in connection with the transformer may be rechecked periodically and the accuracy of the measuring system secured. Indicating and integrating wattmeters are checked by reference to standard wattmeters, the current being of the frequency used in operation. In a similar way recording instruments are checked for accuracy.

The alternating-current generating system in use makes it possible to determine readily the effect of small or large changes in frequency on the accuracy of instruments.

It not infrequently happens that switchboard instruments can not be removed from their places or that they are liable to be influenced by outside causes. In a case of this sort the instrument must be checked in position. One of the chief difficulties of making a check of this kind is to introduce a standard instrument into the circuit in such a way that the latter will not itself be influenced by outside disturbances. Another difficulty is to get satisfactory comparisons between the standard instrument and the instrument to be checked on the fluctuating current of a central station. The first difficulty, which is very far from being an imaginary one, may be circumvented quite readily in certain cases. For instance, in the case of a direct-current voltmeter, it is possible

without introducing appreciable error to extend a pair of lines from the voltmeter to be tested to a standard voltmeter which is placed at such a distance from the switchboard and from heavy cables that it is certainly free from the influence of stray fields. The check then may be carried out by taking a series of simultaneous readings on the two instruments.

With direct-current ammeters the case is somewhat different, since either the heavy currents must be carried to the vicinity of the instrument, or the leads connecting the instrument to its shunt must be unduly extended in order to remove the instrument from the field of outside disturbances. This extension of the leads changes the shunt ratio to a greater or less degree and renders the measurements more uncertain. This uncertainty may largely be removed by making a laboratory check of the standard instrument with the same leads as are used in the central station check.

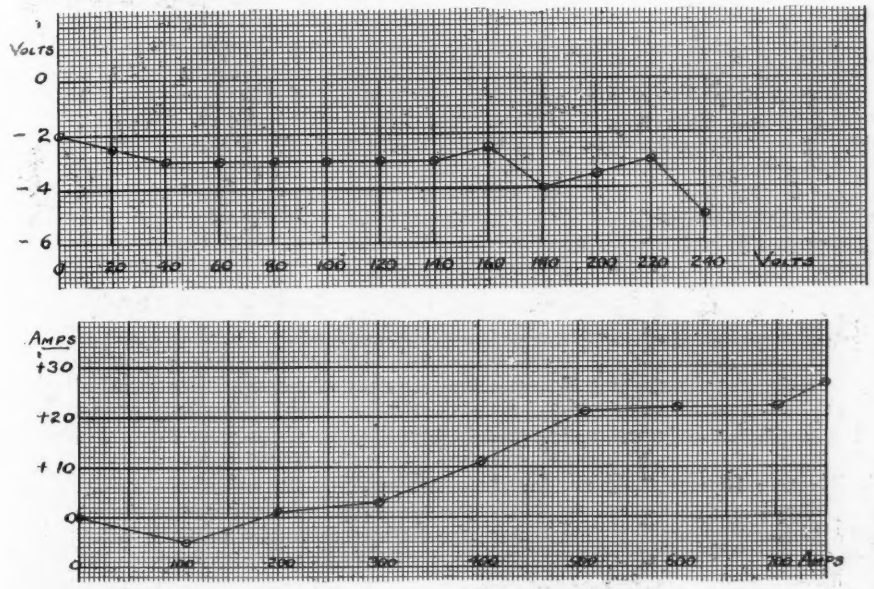


FIG. 1.—CORRECTION CURVES FOR VOLTMETER AND AMMETER.

Alternating-current voltmeters and ammeters have to be checked against standard instruments which themselves have had a laboratory check at the proper frequency and which are removed from the sphere of outside disturbances. In this connection it is important to note that an alternating-current voltmeter or wattmeter of the electrodynamometer type can be used even in the neighborhood of conductors carrying large currents, dynamos, etc., if certain precautions are taken. The necessary precautions consist in sending a current through the moving coil of the instrument alone, the stationary coils being cut out. This can be done with any wattmeter. To do this with a voltmeter, it is necessary to bring out a tap from the line connecting the stationary coils with the moving coil to an extra binding-post on the face of the instrument. When a current is sent through the moving coil alone, if a stray field is present which disturbs the instrument, the needle will, in general, deflect to the one side or to the other of its zero. It is possible, by rotating the instrument, to determine a direction such that the effect of this stray field upon the moving coil is eliminated and the instrument indicates zero, whether the current is on or off. Having made this determination, the direction so found is fixed by setting up two markers in the prolongation of the pointer of the instrument when the pointer is resting on zero. The line so indicated will pass through the pivot of the instrument and through the zero of the scale. When the pointer of the instrument lies in this line the effect of the outside field is nil. Now let the instrument be connected into the circuit in the ordinary way for making measurements. The pointer will be deflected and the moving coil will, in the deflected position, be influenced by outside fields. If the instrument is rotated until the pointer once more comes in the line between the two markers, the influence of the outside field will again be eliminated and the indication of the instrument will be the true indication.

In this way a standardized alternating-current voltmeter can be used for checking a direct-current voltmeter with a good degree of accuracy. It is, however, on general principles better to use an instrument which is itself unaffected by such disturbances. The potentiometer is such an instrument. In its ordinary form the potentiometer is rather too complicated and difficult for ordinary central station use. The advantages of the potentiometer, however, are so great that the Electrical Testing Laboratories have brought out a simplified form of this instrument, which has been introduced into their ordinary practice by a number of the largest electricity supply companies in this country. This instrument, which is known as the Lamp Testing Bureau model, is designed to measure only six voltages, which can be chosen at will. For stations or isolated plants operating on the Edison three-wire system, these voltages are usually 100, 110, 120, 200, 220 and 240. Comparisons are made against the electromotive force of a Weston standard cell. The electromotive force of this cell does not change appreciably with the temperature, so that no troublesome corrections have to be made. The instrument is entirely self-contained and consists of a standard cell, a galvanometer and the necessary resistances, all enclosed in a small box with a cover and lock. Connections to outside circuits are made by opening the cover and joining the leads to binding-posts on the hard rubber top.

This instrument has been found very useful in checking the principal points of a standard voltmeter with which all the other voltmeters connected with the station are compared. If it is to be used for checking the switchboard instruments directly, it should be arranged so that one of its points corresponds exactly to the voltage at which the station is operated. The instrument is light, portable and highly accurate and enables the central station manager to be certain of his most important measurements. It may be used also in connection with a bank of lamps which has been standardized by determining its ampere consumption at a given voltage. With this auxiliary, ammeters and wattmeters can be accurately checked.

It is desirable that all standard instruments should be checked throughout their entire scale against a standard potentiometer; in order to determine variations in their calibration. A check of this sort having been carried out, a curve is plotted showing the error of the instrument at all points. This need be done once for all. Periodical checks can be made with a six-point potentiometer to determine the change in the accuracy of the instrument as a whole. Such a change corresponds to a uniform percentage shift upward or downward of the entire error curve.

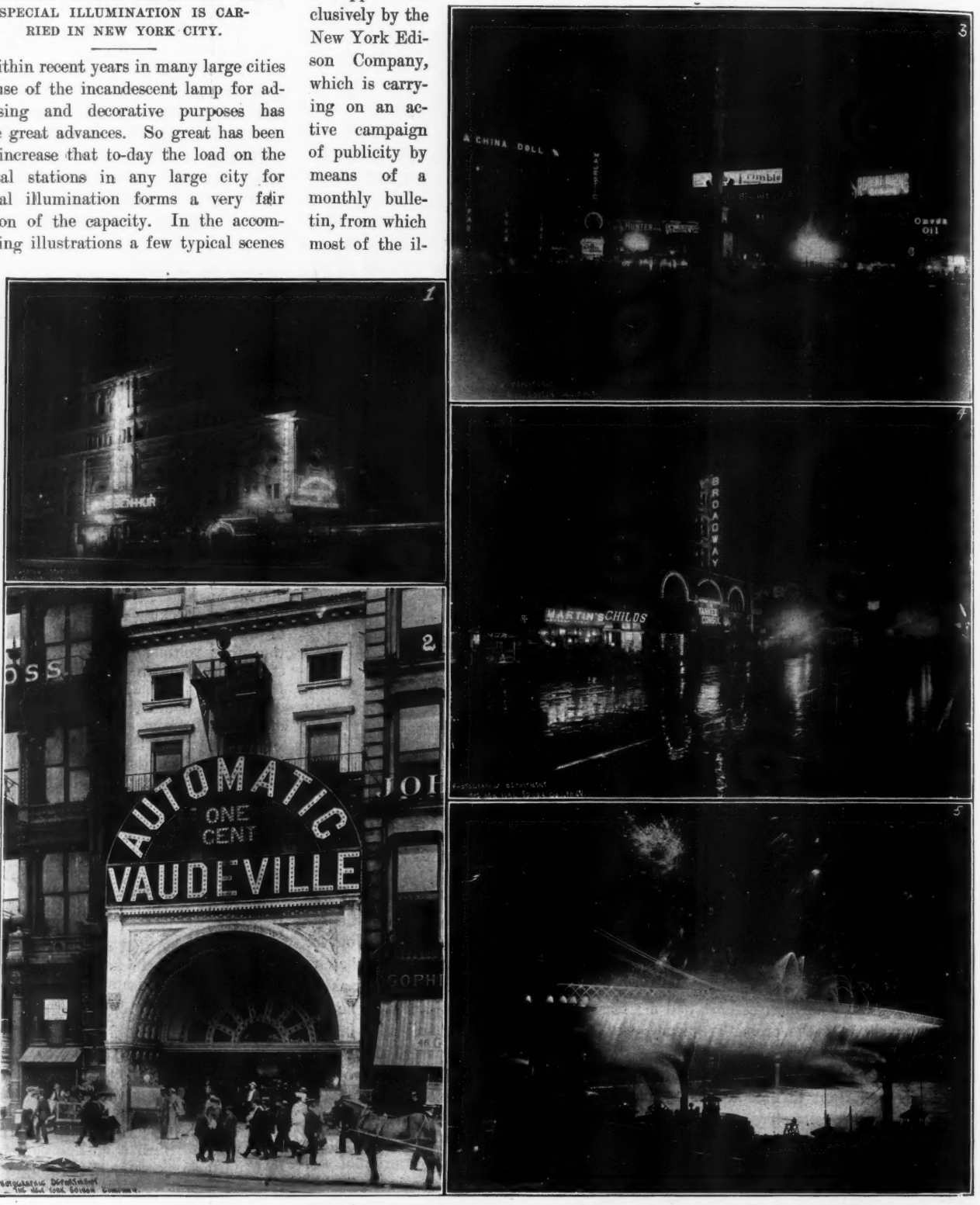
In conclusion, it should be emphasized that whatever method of checking switchboard instruments is employed, such checks are of great importance and should be made frequently, periodically and with great care.

THE USE OF INCANDESCENT LAMPS FOR DECORATIVE AND ADVERTISING PURPOSES.

SOME IDEAS OF THE EXTENT TO WHICH SPECIAL ILLUMINATION IS CARRIED IN NEW YORK CITY.

Within recent years in many large cities the use of the incandescent lamp for advertising and decorative purposes has made great advances. So great has been this increase that to-day the load on the central stations in any large city for special illumination forms a very fair portion of the capacity. In the accompanying illustrations a few typical scenes have been reproduced. These have been made from actual photographs of ordinary conditions. With the exception of Fig. 5 and Fig. 7 the same illumination is seen night after night throughout the year in New York city. For all of the places shown in these illustrations the current is supplied exclusively by the New York Edison Company, which is carrying on an active campaign of publicity by means of a monthly bulletin, from which most of the illustrations herewith have been reprinted. Fig. 1 shows the front of the New York Theatre, in Times square, and is fairly representative of the use that almost every theatre in New York city is now making of the illuminated sign.

Fig. 2 is a daylight picture. It is impossible to get a fair result from a night exposure. So many lights are used on this large sign that the building is one glare of light. There are 2,500 incan-

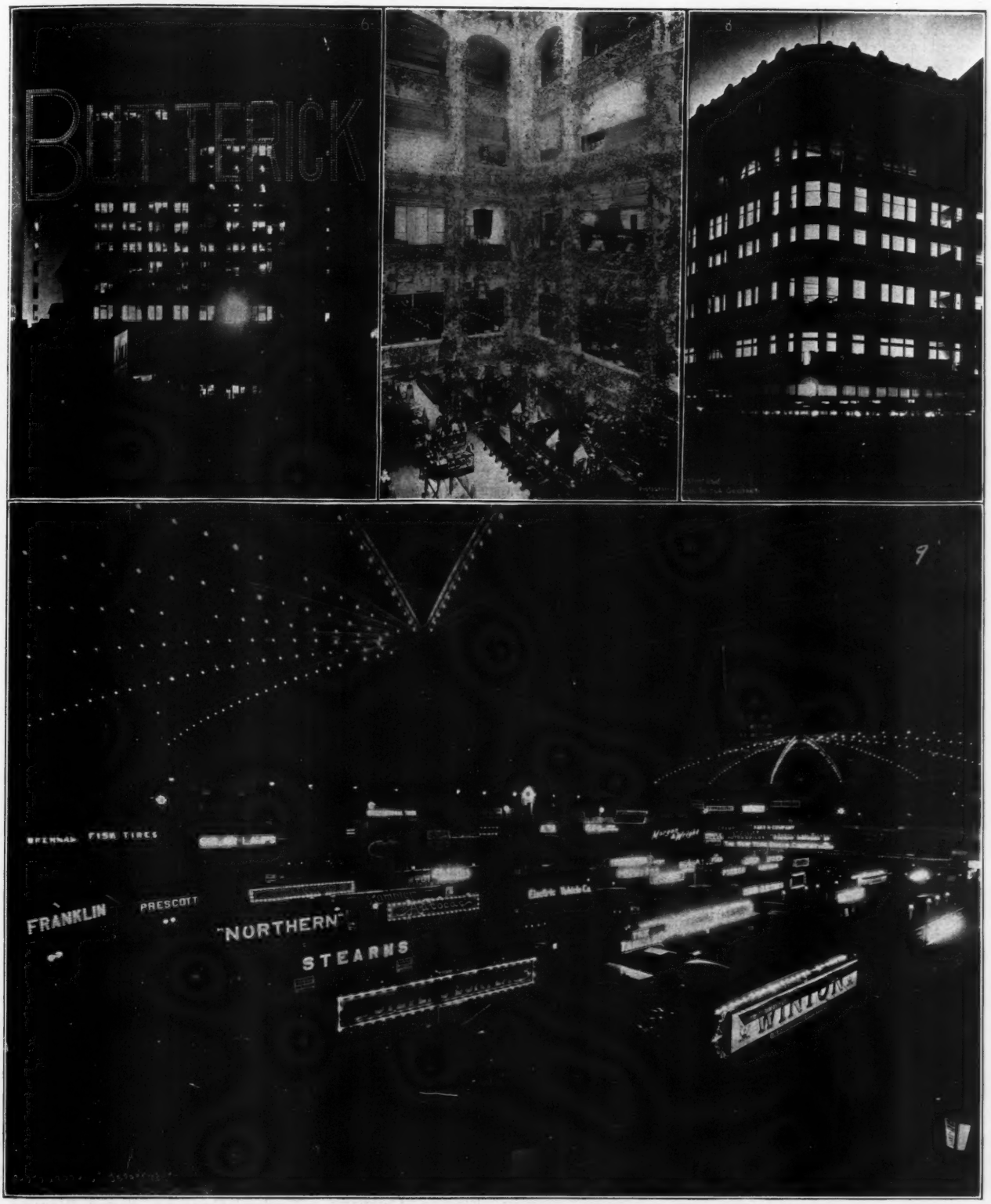


Spectacular and Decorative Illumination in New York City.

descent lamps used in the archway and flashed sign. In addition to this, however, current is supplied for 125 motors which operate the small machines inside the building.

Fig. 3 shows the illumination at the Columbus circle. When it is realized that the nearest light is probably some sixty feet from the Columbus monument, the amount of illumination necessary to produce so clear an effect will be appreciated.

The upper part of Broadway on a rainy night is well shown in Fig. 4. It may be noticed that every store in the block has some form of electric illumination.



SPECTACULAR AND DECORATIVE ILLUMINATION IN NEW YORK CITY.

Fig. 5 is peculiarly spectacular. For the most part the illumination is pyrotechnic, but the photograph has reprinted the tracery of the towers and cables,

which was made entirely with incandescent lamps, the occasion being the opening of the new Williamsburg bridge.

In Fig. 6 is shown the largest illuminated sign in the world. The height of the eight smaller letters following the initial letter is fifty feet, while the height of the initial letter is sixty feet. The lamps are four-candle-power lamps, with a voltage of 120, and a consumption of seventeen to twenty-eight kilowatts. This sign is illuminated for five hours each day. It is lighted just as the business day closes, and is continued almost until midnight. The sign contains 1,152 lamps, which are spaced eighteen inches apart. It is estimated that the cost of maintenance of this sign is about $3 per day. The sign was designed and erected by the Electric Motor and Equipment Company, Newark, N. J.

Fig. 7 is a fair example of the extent to which interior decoration may be carried with the aid of incandescent lamps. This view shows the spring opening of the Simpson, Crawford Company. Flexible cables are entwined with smilax and other green decorations, presenting a beautiful effect which could be approached by no other form of illumination.

The large amount of light used for practical interior illumination is well illustrated in Fig. 8. This photograph was made during the Christmas holidays, when the building was lighted from top to bottom.

One of the most recent illustrations of sign lighting, and the flexibility of electric distribution, is shown in Fig. 9. This photograph was taken during the recent automobile show in Madison Square Garden, New York city. It is easily seen how the general scheme of illumination has been almost obliterated by the intense light thrown out by the various illuminated signs.

Seventh Annual Convention of the Electrical Contractors' Association of New York State.

The seventh annual convention of the Electrical Contractors' Association of New York State was held at Troy, N. Y., on Tuesday, January 17. The convention headquarters were at the new Hotel Rensselaer. The contractors from the western end of the state and from New York city began to arrive Monday evening. The real work of the convention began at 9 A. M., with the directors' meeting, which was held at the Chamber of Commerce.

There were present at this meeting the full board of directors, as follows: J. C. Sterns, Buffalo association; Frank L. Frost, Eastern New York association; James R. Strong, New York city association; Morris J. Almstead, Rochester association; James S. Hilton, Syracuse association. President Marshall L. Barnes, of Troy, was in the chair, and Fred Fish at the secretary's desk.

This session was executive, and a large amount of routine business was transacted.

The delegates' meeting was called to order at 10.30 A. M. Mayor Hogan welcomed the delegates to the city in a very pleasing address. A response was made by Vice-President James R. Strong, of New York.

At roll call the following contractors answered:

Julius C. Sterns, of J. C. Sterns & Company; J. D. Robertson, of the Robertson Electrical Construction Company; H. I. Sackett; F. H. Williams, of F. P. Little Electrical Company; Emmett Fleming, secretary Buffalo local association, Buffalo. Marshall L. Barnes, of Barnes & Payton, Troy. F. W. Newman, of the Albany District Telegraph Company; Morton H. Havens, Jr., Albany. K. C. Radliffe, of the Hudson Valley Electrical Supply Company, Watervliet. Harvey R. Collins, Mechanicsville. J. W. Wright, of J. W. Wright Company, Sandy Hill. Frank L. Frost and A. G. Sheldon, of Frost & Sheldon, Albany. E. G. Bernard, of E. G. Bernard & Company; C. E. Hindsill, of the Troy Electrical Company, Troy. James F. Burns, Schenectady. Mr. Hughes, of the Central-Hudson Construction Company, Poughkeepsie. A. L. Payton, of Barnes & Payton, Troy. A. E. Clute, of Clute Brothers, Cohoes. W. H. Morton, of Johnson & Morton; G. C. Brayton, of Brayton & Hooks, Utica. L. M. Blanding, of the Binghamton Electrical Construction Company, Binghamton. A. Stewart, of Stewart & Bergen, Fort Plain. James R. Strong, of the Tucker Electric Construction Company; A. J. Martin, of the Commercial Construction Company; Robert Lawrence, of Edwards & Company; J. C. Hatzell, of Hatzell & Buehler; George Wm. Russell, Jr., of Russell & Company; E. A. Kuefer, of the construction department Western Electric Company, New York. Rudolph Schmidt, of Rudolph Schmidt & Company; Morris J. Almstead, of the Almstead Electric Company; Clarence Wheeler and Harvey Smith, of the Wheeler-Green Electric Company; Fred Fish, of Fish & Horton Company, Rochester. James S. Hilton, of Rogers & Hilton, Syracuse.

W. H. Morton, secretary National Electrical Contractors' Association, Utica, N. Y.; J. P. Coghlin, third vice-president National Electrical Contractors' Association, Worcester, Mass.; George M. Chapman, director for state of Connecticut, National Electrical Contractors' Association, Waterbury, Ct., were present as visitors.

The meeting then went into executive session until noon when an adjournment was had and the members and their guests were entertained at the works of E. G. Bernard & Company. From the Bernard works the guests were escorted to the Fifth Avenue Hotel where luncheon was served.

At 1.15 P. M. the guests went to the collar and shirt factory of Cluett, Peabody & Company, and were shown through the works by representatives of the management. Returning to the Hotel Rensselaer the regular session was resumed at 2.30 P. M. and lasted until 7.30.

At this session the following officers were reelected for 1905: president, Marshall L. Barnes, Troy; vice-president, James R. Strong, New York; secretary, Fred Fish, Rochester; treasurer, Julius C. Sterns, Buffalo.

Directors of National Electrical Contractors' Association for New York State: James R. Strong, New York; Marshall L. Barnes, Troy; James S. Hilton, Syracuse.

At 8.30 P. M. the members and guests sat down to a banquet at the Hotel Rensselaer.

Addresses were made by the following speakers: national Vice-President J. P. Coghlin, of Worcester, Mass.; ex-state President Rudolph Schmidt, of Rochester; Thomas H. Bibber, of Boston, Mass.; state Vice-President James R. Strong, of New York; Fred W. Newman, of Albany; C. E. Corrigan, of New York; Dr. William N. Campaigne, of Green Island, and Samuel E. Hutton, secretary of the Troy Chamber of Commerce.

Among those present were the following traveling men: Alex. Henderson, of the Sprague Electric Company; Avery P. Eckert, assistant treasurer Safety Insulated Wire and Cable Company; C. E. Corrigan, of the Osburn Flexible Conduit Company; Arthur Dunlop, of the Bernard Company; H. C. Owen, of the Western Electric Company; V. C. Gilpin, of the DeVeau Telephone Manufacturing Company; George W. Swan, of the John A. Roebling's Sons Company, New York. Thomas H. Bibber, of the American Circular Loom Company; James E. Wilson, of the Stuart-Howland Company, Boston, Mass. J. C. Moulton; H. P. Kimball and C. Wiesblatt, of Standard Underground Cable Company; J. C. MacDowell, of the Manhattan Electrical Supply Company, New York. A. M. Little, of Pass & Seymour, Syracuse.

TENDENCIES IN CENTRAL STATION DESIGN.

BY WILLIAM H. BRYAN.

In considering the subject of present tendencies in central station design, it seems very evident that a matter for just consideration is the design of the boiler room upon advanced lines. Until quite recently this portion of the plant has usually been given scant attention, almost anything being good enough. This precedent thus established by the designer has been followed by the attendants in charge, who have neglected it. At the same time, a wealth of brains and energy has been devoted to the engine and generator rooms, and to methods of distribution. Of late there has been a growing tendency to change this situation, due, no doubt, to a tardy realization that marked economies are possible with a well-designed boiler room.

Among the features most worthy of encouragement are:

1. A better understanding of the possibilities and limitations of automatic stoking.

2. Automatic fuel and ash-handling apparatus, and fuel storage.

3. Higher pressure boilers with superheaters.

4. A realization of the fact that smoke-making always means fuel waste.

5. A better understanding and appreciation of benefits of economizers and mechanical draught, the latter particularly where sudden and severe overloads must be cared for.

6. The elimination of scale, oil and other impurities from the boilers.

Other details which are having intelligent study and which promise profitable results are:

7. The use of briquettes made from inferior and waste fuels.

8. Methods for the use of powdered fuel.

Accompanying all this is a better understanding of the detailed and convenient arrangement of boiler-room apparatus, and better provision for easy access to all parts, together with improved light and ventilation.

Another direction in which there appears to be a tendency toward development, is the increased and more intelligent use of exhaust steam for heating, and other by-processes, and a realization of the fact that condensing engines may be operated profitably in connection with heating systems, with advantage both to the engine and to the heating system.

A Long-Distance After-Dinner Speech.

The Paper Trade Association was addressed at its recent dinner in Boston, Mass., by the Hon. William S. Greene, member of the House of Representatives, but as his duties prevented the congressman from coming to Boston, arrangements were made by which he spoke into a transmitter at Washington, while at the Somerset, where the dinner was held, 500 miles away there were forty receivers connected to the long-distance line and placed at the tables so that the guests could hear the address without rising from their seats.

The president of the association introduced the congressman in the usual manner, except for an apology at their departure from strict hospitality in asking to speak a person who had not already been with them at table, while a nearby transmitter also enabled their Washington guest to hear the presentation, which he acknowledged by saying that it was an appreciated honor to appear before such a fine-looking body of men, and then he plunged into an earnest plea for their cooperation in the development of foreign markets for the products of American manufacture, speaking in this line for about fifteen minutes, every word of which was as clear to those present as if he was at the table.

Their guest at Washington was also able to hear the applause which greeted his eloquence and wit.

The other speaking of the evening was devoted to the telephone in accordance with the Boston custom of providing a symposium on a theme, the modern Athens in this respect following the custom of ancient Athens, as related in the Dynosophists of Athanæus.

The Hon. Michael J. Murray eloquently spoke upon the telephone in its relation to the law, and C. J. H. Woodbury of the American Telephone and Telegraph Company illustrated by a few experiments the principles of the operation of the telephone, and then by means of some large models showed the construction of receivers and transmitters.

The telegraphone was brought into the room, charged with a message which was transmitted to the guests, after which the magnetized wire was cleared with a magnet, and the cornet player of the orchestra played a selection into the instrument in the presence of the guests, making a record which served an encore, given through the same telephones which delivered the address from Washington.

Afterward the record of the solo was given backward, the disconnected toots of the cornet having little resemblance to the original record and serving as an object lesson upon the rules of musical composition, which are as positive as those of grammatical construction of speech.

New York Electrical Society.

The 248th meeting of the New York Electrical Society will be held in the assembly room of the Metropolitan Street Railway Association, 761 Seventh avenue, New York city, on Wednesday evening, February 15. Mr. Herbert H. Vreeland, president of the New York City Railway Company, will address the society on "Electric Railway Operation in a Great City." Mr. Vreeland will discuss the development of electric railways in crowded municipalities, with special reference to the relation of the electrical engineer to the operating department. He will show precisely what the ends are that manufacturing engineers must conserve in the construction of a machine which low-salaried men must always be capable of handling. He will describe in detail the organization of a great railway company in a thickly populated community, the relation of the various departments, and the consequent varied points of view which the electrical engineer must have in mind in dealing with this particular subject.

Mr. Vreeland's address will be based on thoroughly practical lines, and will embody the wide experience, not only of himself, but of other eminent and successful men.

Sources of Radium.

In a report from Mr. Joseph I. Brittain, United States consul at Kehl, Germany, it is stated that the slime or residiuum of the thermal springs of the city of Baden-Baden, Germany, contains considerable quantities of radium salts. Professor H. Gertel, of Wolfenbüttel, says that the radium compound extracted from these deposits is forty times more powerful than that found in the residiuum of cold-water springs or in mud baths. Heretofore these deposits have been considered worthless, but they are now carefully collected and sent away for treatment. These baths have for a hundred years had the reputation of possessing healing qualities.

The railroad department of the international committee of Young Men's Christian Associations is distributing an attractive pamphlet describing the work accomplished by this department during the past year, and giving the outlook of the future. It describes and illustrates the buildings owned by a number of the railroad associations, some of which are valued as high as $25,000.

The Automatic Telephone Exchange at Battle Creek, Mich.

THE Automatic Electric Company, Chicago, Ill., has recently installed one of its automatic telephone exchanges for the Citizens' Telephone Company, of Battle Creek, Mich. This company is controlled by the Citizens' Telephone Company, of Grand Rapids, Mich., which has been using the automatic system since January, 1904. It is significant of the satisfaction which automatic service has given the operating company and the subscribers in Grand Rapids that the former should be equipping its other exchanges with automatic apparatus.

The Battle Creek exchange was installed for a capacity of 1,000 individual lines, the system having an ultimate capacity of 10,000. A trunking capacity of ten per cent is allowed and is capable of being increased to any desired amount should it become necessary.

The switches are mounted on angle-iron framework, there being five shelves to each unit, and a total of ten units, each unit holding switches for 100 subscribers. Each shelf is capable of holding twenty-five switches, the bottom shelves being equipped with first selectors and being entirely filled. The top shelf is equipped with ten second selectors on the left-hand end and ten connectors at the right end. An angle-iron footguard is arranged at the base of each unit in such a manner that it is impossible for a person walking in front of the switches to accidentally damage them by running against them.

Beeswaxed switchboard cable is used for the switchboard cabling and this is all run to the top of the units and thence in angle-iron runways to the various points as is required. The current for use in connection with the switches is brought to a slate main feeder terminal—carried through fuses and distributed to the various boards. On this main feeder terminal are mounted special tell-tale relays so wired that in case any fuse blows an audible alarm will immediately be given. Each switch is further protected by a self-soldering heat coil of the Automatic Electric Company's make. When any one of these heat coils blows an audible alarm is also given and a lamp lighted showing on which shelf the fuse is burned out.

Power for operating this exchange is furnished by two sets of storage batteries. One set consists of twenty-seven cells of 150-ampere-hour capacity, the other set consists of twenty-seven cells of 100-ampere-hour capacity, each set being contained in 150-ampere-hour glass jars. These batteries were made by the American Battery Company. The cells are mounted on a special battery rack consisting of two divisions, each division having two shelves. Each individual cell is mounted on a specially prepared wooden base, which in turn is mounted on porcelain insulators, and the shelves are so arranged that any base may be removed and the jar taken out through the bottom of the shelf without disturbing the elements.

Arrangements were made for charging these storage batteries by means of two Holtzer-Cabot motor-generator machines in duplicate. The motor of each being 110-volt, sixty-cycle, single-phase, direct-connected to a dynamo capable of delivering nine kilowatts at seventy-five volts. Current for ringing, and also for busy and howler attachments, is furnished by two ringing machines, one machine consisting of one-fourth-horse-power, 110-volt, sixty-cycle, single-phase motor, direct-connected to an eighty-volt, twenty-cycle ringing generator. The other machine consists of one-sixth-horse-power dynamotor, primary wound for fifty-five volts, the secondary to deliver eighty volts, twenty-cycle alternating current. Both of these machines were also made by the Holtzer-Cabot Electric Company. The one-sixth-horse-power fifty-five-volt dynamotor is intended for night service and for emergency work and is to be run from the storage battery. The four machines are placed on slate bases mounted on an iron machine pier.

The machines, storage batteries and also the power for the switchboard are controlled from a power-board which is constructed of pink Tennessee marble mounted on an iron frame. On the front of this board are mounted copper switches (each switch being designated by a name-plate showing its use), also enclosed fuses, underload and overload circuit-breaker, tell-tale lamps from each board in the exchange, Weston voltmeter and ammeter are arranged with switches so that readings may be taken on any of the different circuits. One feature of this power-board is that there is no wiring on the back of the board except at the point where a connection is made, an iron

General View of Interior of Automatic Exchange of the Citizens' Telephone Company, Battle Creek, Mich.

Switches and Selectors, Automatic Exchange of the Citizens' Telephone Company, Battle Creek, Mich.

power rack situated about eight inches from the back of the board receiving all wires and carrying them to the power runway.

The board is lighted by two incandescent lamps with green shades and artistically curved supporting arms, one in front of the voltmeter and the other in front of the ammeter.

The outside lines are brought in through lead-covered cable to sealed terminal heads and thence to the distributing board of the F. B. Cook type. This distributing board is equipped with self-soldering heat-coils and carbon lightning arresters and is so arranged that any outside line may be connected to any switchboard line by simply running jumper wires; thus any subscriber, upon moving, may be allowed to keep his old number.

A combined wire chief's and information clerk's desk is furnished, the wire chief's desk being arranged for making various tests on the lines. The cabinet is of highly polished golden oak and on it are mounted a Weston voltmeter, keys and lamps for operating the various circuits and one set of standard switches for testing the outside lines direct to the wire chief's desk without going through the regular board, also arranged with two Automatic Electric Company's nickel desk sets.

Information position is so wired that a subscriber making a wrong call and calling it on a dead-line is connected with the information clerk and can thus be instructed to make the proper call. In the same manner telephones out of service are brought into this information desk as well as certain lines which are designated for information trunks.

The toll-board is furnished by the local company and is so arranged that any subscriber by calling "O" at his telephone is connected directly with the toll-board and by pushing his ringing button signals the operator, to whom he gives his directions.

Meeting of the American Trade Press Association.

A general meeting of the members of the American Trade Press Association will be held in the rooms of the Hardware Club, 253 Broadway, on Friday evening, February 17, at six o'clock. On this occasion Mr. Arthur E. Warren, director of the department of publicity of the Allis-Chalmers Company, Milwaukee, Wis., will be a guest of the association. Mr. Warren will deliver an address on the "Sphere and Usefulness of the Technical Press from the Manufacturer's Standpoint." A large attendance is particularly desired. Mr. L. J. Montgomery is secretary of the association.

The Electrification of the London, Brighton & South Coast Railway, England.

The English journals announce that the London, Brighton & South Coast Railway Company has decided to electrify a portion of its suburban system. This decision is not due to a sudden impulse on the part of this company, or a wish to follow the lead of other railway companies. The matter has been under consideration for the last few years, and Mr. Philip Dawson has been at work upon this question for the past three years. Every phase of the situation has been gone into thoroughly, and very voluminous reports have been made.

The report which was presented to the directors early in July of last year comes to the conclusion that a third rail was out of the question, not merely because of its somewhat dangerous nature, but because of the existence of Clapham Junction, which is said to be the busiest railway junction in the world. To carry a third rail through the maze of rails existing there would be merely to set a death trap for trackmen. Since the single-phase motor has become available, the use of the third rail may be avoided, and the directors of the railway company have decided to proceed at once with the equipping of a portion of the system with this type of motor. The portion which will be electrified first is that section which lies between Battersea Park and Peckham Rye.

The electrification of this road will aid greatly in relieving the pressure at the great London termini. Much of the delay there in getting the trains in and out is due to the necessity of shunting the locomotives, an operation which can not be completed at London bridge in a less period than seven to eight minutes with steam haulage. With electric traction there will be no necessity for shunting, and it is anticipated that a train will depart again within two minutes of its arrival. This will increase the possible number of trains handled at these tremini about three times.

The management of the road will also turn its attention to developing the more remote suburban districts within a radius of thirty miles. Hitherto it has been out of the question to attempt this, on account of the impossibility of accommodating a single additional train at the termini.

Another reason which has had some influence in bringing about this decision is the effect upon the railway of the electric tramways in the same section of the country. Nearly every branch of the road is paralleled by an electric tramway.

The main features of the system will be as follows: power will be generated at New Cross. The generators will be driven by steam turbines; and the station will be erected on the complete unit system. The alternators will generate current at 6,600 volts, twenty-five cycles, and power will be supplied directly to the overhead conductors at 6,000 volts, without the interposition of any transformer apparatus whatever. The conducting cables will be laid underground, and each section of the working conductor will be separately fed near the middle of its length. Switch gear will be provided in signal boxes controlling the distributors, and for coupling sections of the conductor together in case of necessity. The running rails will not be bonded together for the return current, but each rail will be bonded to a concentric cable laid underground between the tracks, while the inner conductor of the cable will constitute a high-pressure distributor. The rolling stock will consist of two-truck cars, divided into sections, with side doors. The cars will be open from end to end above the seats. The sliding doors will be operated by compressed air or by hand. Current will be collected from the overhead conductor by a sliding bow. The traffic over the Peckham Rye section, between Victoria and London bridge, amounts to 7,000,000 passengers per year, exclusive of short-distance passengers and season ticket-holders.

Notes on Induction Integrating Wattmeters and Their Use.

At the second annual meeting of the Colorado Electric Light, Power and Railway Association, held at Colorado Springs, Col., September 21-23, 1904, Mr. A. A. Serva delivered an address on "Induction Integrating Wattmeters and Their Use." This paper has been reprinted and is being distributed with the compliments of the Fort Wayne Electric Works, Fort Wayne, Ind.

The paper takes up in detail the theoretical considerations involved in the construction and operation of the induction integrating wattmeter, giving diagrams of the connections and showing a number of interesting performance curves. The apparatus under consideration is the type K wattmeter manufactured by the Fort Wayne Electric Works, and a number of carefully prepared half-tone illustrations exhibit all of the assembly and mechanical details of this apparatus. The paper is well worth going to a good deal of trouble to secure.

Reviews of Current Engineering and Scientific Literature.

A Model Illustrating Hittorf's Theory of the Migration Velocity of Ions.

An ingenious model, which may be used as an aid in explaining the conception of Hittorf, is here described by Mr. Frederick H. Getman. The model consists of a baseboard fifty centimetres long and seven centimetres wide, upon which are two upright supports. Through these supports pass two cylindrical wooden rods, six millimetres in diameter and forty-seven millimetres long. Upon these rods are placed sixteen wooden balls, eight on each rod, one set of eight being colored black, the other set white. Across the top of the support is fastened a scale divided into sixteen equal parts. Between the third and fourth divisions and the twelfth and thirteenth divisions are placed two light strips of wood which represent the electrode. To make the use of the model clear, suppose the anion of the electrolyte to have a velocity twice as great as that of the cation. The row of balls which represents the anions is then moved two divisions to the right or left, and the other row is moved one division in the opposite direction. This will leave at each end three unpaired balls, which are to be moved beyond the vertical partition, this action representing their removal from the electrolyte. Upon inspection of the model it will be found that there has been a transference in the electrolyte, and while each anion is paired off with a corresponding cation, they are not disposed symmetrically about the meeting line. A common abacus might be used as a model of this kind.—*Abstracted from Science (New York), January* 27.

Electric Radiography.

If, upon an electrified plate of ebony, a tube containing a salt of radium is placed, and allowed to remain for ten or fifteen minutes, and then the plate be dusted with a mixture of sulphur and red lead, such as is used in making the Lichtenburg figures, upon the surface of the plate will appear, according to Herr V. Gabritschewski, images of all objects which have been resting upon it or held immediately over it. It is not necessary that the tube containing the radium should be upon the plate. The effect will be the same whether it is held some distance away, or even upon the other side of the plate. If only half of the plate is charged, and the radium be placed upon the neutral part, a yellow image of the radium tube is formed in a weak red field, and there will be found two parallel straight lines, marking the boundary between the electrified and the neutral portion of the plate—one a red line on the electrified half, and the other a yellow line. If three vertical rods are placed in line on the plate, and the tube containing the radium compound is held in line with them, each rod will form an image on the plate. The one nearest the radium tube will be oval and eccentric to the rod, projecting away from the tube. The one at the far end of the row will also be oval, but will project toward the tube, while the central image will be oval, but will be symmetrically placed with regard to the rod. These effects are explained by the inductive action set up between the electrified plate and neighboring bodies.—*Translated and abstracted from the Physikalischer Zeitschrift (Leipsic), January* 15.

The Electrical Equipment of a London Hospital.

A description is here given of the electrical equipment of Guy's Hospital in London. There is a large Finsen-light apparatus, which enables four patients to be treated at the same time. There are, in addition, a smaller Finsen-Reyn lamp and a Lortet-Yenoud lamp, used for the treatment of single patients. A complete high-frequency equipment enables high-frequency currents to be used in treating rheumatism and neurasthenic conditions. Direct current is available for hydro-electric bathing, and for applying electrolysis. Vibratory massage apparatus and a large motor-driven Wimshurst static machine are installed, as well as a complete Rœntgen-ray outfit.—*Abstracted from the Electrical Review (London), January* 20.

Reversal of Charge from Electric Induction Machines.

In this communication Mr. V. Schaffers refers to the method of reversing the charge of static machines which was mentioned in the ELECTRICAL REVIEW for January 28, and he gives the following method, which is said to be more trustworthy and simpler than the other. This consists in discharging by hand, at the same time, both the inductors of the fixed disc. Then a reversal is invariably observed without stopping the machine.—*Abstracted from Nature (London), January* 19.

Electric Automobiles.

A critical study of present practice in the construction of electric automobiles, and suggestions as to the best method of improving it, are here given by M. R. de Valbreuze. Seven or eight years ago it was hoped that the electric automobile would rapidly come into use. To-day these vehicles are considered as luxurious and as suitable only for short runs. Practice has shown that the electric automobile can not make an average of over forty-five to fifty kilometres on a single charge, if the batteries weigh only one-third of the total weight of the car and are not improperly treated. This is rather surprising, since during the automobile trials of 1898 the electric vehicles were rated as having ranges of from 92 to 107 kilometres. It would seem, therefore, that there has been retrogression rather than progression in the construction of these vehicles, but when account is taken of the many ways in which losses of energy occur, and remembering the improvement which has been made from the point of view of stability, it is found that there has been considerable advance. The author then takes up in detail the question of the batteries, the system of driving, and the methods of regulating speed. It is customary to-day to separate the batteries into two sections, mounting one in the front and the other in the rear of the vehicle. While this gives a good distribution of weight and easy riding, it is bad, because this arrangement makes it difficult to take proper care of the cells, and results in their neglect. It is better to place the batteries under the seat of the driver, and arrange this so that it may be lifted up, thus making access to the cells easy. The usual method of increasing the capacity of accumulators is to use lighter plates and increase the density of the battery, but this gives a weak cell and one which is quickly sulphated. The author believes that Planté plates may be constructed no heavier than the pasted plates, and he believes that this is the proper direction in which to work. With frequent washings the positives of this kind will give 250 to 300 dis-

charges, and batteries of this kind are not affected seriously by bad treatment. There are several ways of driving the cars, but two points should be borne in mind. One is that the system of driving and transmission should be as simple as possible, and easy of access. The second is that all parts should be made as light as possible. The first point is too frequently neglected. In regard to the second, it is not sufficiently realized that a slight increase in the weight at any point calls for a corresponding increase in the weight of the batteries. This gain makes it necessary to strengthen the car so as to carry this extra weight of battery. It will be found that an increase in weight of any part of the car other than that of the accumulators will increase the total weight of the car by nearly twice as much. There are two main methods of driving, one using a single motor, and the other making use of two or more motors. The single motor drive gives a lighter equipment and a higher efficiency, but makes necessary a differential gear. While two motors enable the differential to be done away with, the motor equipment is less efficient and weighs more. In any case, it is desirable to use light, and hence high-speed motors. The advantages of the different methods of transmitting power from the motor to the axle are considered. The cost of upkeep of a battery is given as about thirty-five dollars a month. The total cost of keeping an electric automobile is given at $218 per month.—*Translated and abstracted from L'Eclairage Electrique (Paris), January* 14.

The Power Plants in the Canadian Niagara District.

A detailed account is given here by Mr. Cecil B. Smith, until recently in charge of the Canadian Niagara Power Company's plant, of the various power schemes now being carried out at the Canadian side of Niagara Falls. The total hydro-electric development of Canada is now about 228,000 horse-power. This puts Canada next to the United States, and gives her one-tenth of the world's total. The Niagara district presents unusually favorable conditions for hydroelectric development, such as certainty of water, but slight fluctuations in head, vigorous and varied markets, and reasonable freedom from ice troubles. Although there are no large cities on the Canadian border at Niagara, the total population of south-western Ontario, within 125 miles of Niagara Falls, is about 1,500,000. A number of United States firms are building large Canadian works, where it is expected a good part of the power generated will be employed. The older plants on the Canadian side are those located along the Welland canal, there being at De Cew Falls a plant operated by the Hamilton Cataract, Power, Light and Traction Company, where the head is 267 feet, and the output of the station about 6,000 kilowatts. The old Welland canal has been practically closed to vessel traffic. The Dominion government has leased to various users limited quantities of water on each level, in addition to that already so used while the canal was in operation for vessel traffic. In this way a large number of small stations have been equipped, operating under falls of from twelve to fourteen feet, the power thus produced being used for various purposes. The Hamilton company has also secured from the city of St. Catherines the water rights in the Beaver Dam valley, and is equipping there a power-house which will have an initial capacity of 16,000 kilowatts, but which may ultimately be increased to 42,000 kilowatts. The International Railway Company's plant at Niagara Falls is equipped with two 1,000-horse-power vertical turbines operating at fifty-five feet, which drive three 200-kilowatt railway generators and two 450-kilowatt, 2,200-volt alternators, now used by the Canadian Niagara Power Company. The Canadian Niagara Power Company's plant is similar to that of the Niagara Falls Power Company on the American side. This station, however, has adopted 10,000 electrical horse-power units, with a consequent shortening of the wheel-pit and power-house from eighty to forty-eight feet per 10,000 horse-power. The tail-race tunnel, which will make available 110,000 horse-power, is now finished. The wheel-pit is 570 feet long, eighteen feet wide, and varies from 165 to 148 feet in depth. The present installation will have an output of 50,000 horse-power. The turbines will operate under an effective head of 136 feet. The Ontario Power Company will draw water from the neighborhood of Dufferin Islands, carrying it through a flume which is formed of an eighteen-foot steel pipe encased in concrete to Table Rock, where the penstocks branch off downward to the turbines situated in the generating station at the base of the main cliff. The receiving station will have a capacity of 180,000 horse-power, but the single eighteen-foot flume now being built will develop only 60,000 horse-power. The water through this flume will flow at the rate of fifteen feet per second. There will be six 10,000-horse-power units in the present equipment. The Toronto & Niagara Power Company is using the wheel-pit construction, and is cutting a tunnel 1,900 feet long under the bed of the river to a point immediately behind Horseshoe falls. By reversing the alternate penstock positions, the wheel-pit of this company has been reduced from ninety-six feet to seventy-five feet per 20,000 horse-power. The power-house will ultimately contain eleven 8,000-kilowatt, three-phase, 12,000-volt alternators. This company purposes transmitting current to Toronto—eighty miles—by three-phase, 60,000-volt transmission. The wire is to be carried on steel towers 400 feet apart. There are now between twenty and thirty million dollars being invested in developing the water power on the Canadian side. While a good deal of the power generated will be used in Canada, it is expected to export a large amount of it to the United States whenever additional markets are found. It is thought that the railways will turn to electricity as soon as they are sure of continuous service, and that this will utilize a good part of the output of the Niagara Falls plants. It is difficult to estimate what these different demands will amount to, but as there will be from 150,000 to 175,000 horse-power on the market from these plants within a few years, and as they are being developed with a view to a total output of 375,000 to 400,000 horse-power, it is a safe conclusion that the probable demand within the next five years will about equal the smaller amount mentioned. On the other hand, it is hard to conceive of a total demand in both countries, within a reasonable distance of Niagara Falls, for more than 500,000 horse-power within the next generation.—*Abstracted from the Engineering Magazine (New York), February.*

Electric Lighting of Trains in Belgium.

United States Consul James C. McNally, Liege, Belgium, reports that the Belgian government railway authorities have for some time past been engaged in building a locomotive equipped with a dynamo and storage batteries, for lighting electrically a train of several cars. The batteries are not placed on the cars, on account of their weight. This experimental train is now about ready, and will be tested in a short time.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Thomas Soldered Rail Bonds.

The Lord Electric Company, 112 Water street, Boston, Mass., makes the Thomas soldered rail bond, a number of forms of which is shown in the accompanying illustrations.

The type A bond, shown in Fig. 1, is

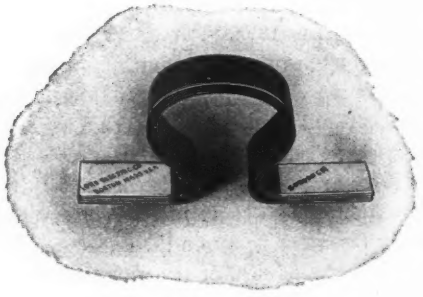


FIG. 1.—TYPE A BOND.

used for track, third rail or structure bonding, where large capacity is required. Where joints are suspended it is usually applied to the base of the rail, although it can be applied to the top of the flange in many cases. It can be used to great advantage wherever the base of the rail is exposed. On new work where the joints are to be suspended these bonds can be applied with the rails turned bottom up in sections of about 300 feet. This section, joined by fish-plates, can easily be turned by four men. After the bonds have been applied and the ends of each section thoroughly tinned, the rail is turned and spiked, leaving only the bonds connecting the several sections to be applied. This type of bond can be applied to old work without removing the bolts or joint-plates, or interfering with traffic. The base of the rail affords ample contact area for a

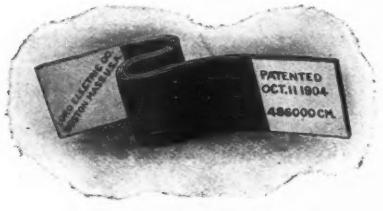


FIG 2.—TYPE B BOND.

bond of large capacity. A screw or bolt may be used to hold the bond more firmly than by soldering alone. It is put through the rail flange into the bond, and serves the double purpose of a clamp to draw the bond into contact with the rail during the process of soldering, and then aids the solder to resist the strains due to the motions of the rail in regular service.

The type B bond is shown in Fig. 2. It is adapted for use where the fish-plates or angle-plates are used as a conductor, and where the base of the rail is not accessible. It is also used where the space under the joint-plates is too limited for a concealed bond of the required capacity, or where it is too difficult or expensive to remove the joint-plates and bolts. If applied from rail-web to joint-plate, and *vice versa*, it is virtually a substitute for the long bond around the plate, and is much lower in first cost and less liable to theft. The bond is provided with a series of slots to increase the vertical flexibility of the bond, and to provide for the motions of the rail in that direction, as well as for the regular expansion and contraction.

The type C bond, shown in Fig. 3, is

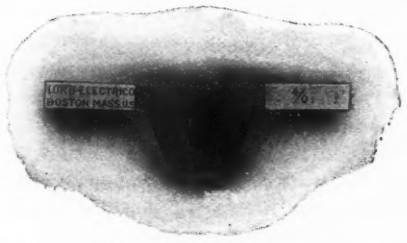


FIG. 3.—TYPE C BOND.

used for bonding guard rails, and can be applied to either new or old work. It can be used on the side ball of the rail, opposite the flange, or as a concealed bond under the joint-plates. This type of bond can be applied without interference to traffic, making a very inexpensive and satisfactory installation on suburban lines where there is no street traffic.

Where continuous or Weber rail-joints are used the available space for concealed bonds is increased. By utilizing the space on both sides of the rail-web under such bonds, it is possible to obtain large capacity, although seldom equal to the capacity of the rail.

The type D bond, shown in Fig. 4, is a new departure in the utilization of the space under joint-plates. It avoids the difficulties of the plug terminal type of bond, and can be readily applied under any of the existing types of angle-bars or joint-plates which afford opportunity for any bonding whatever between the rail and plate. It can be easily applied to existing roads, the necessary punching in the ends of the rails being done by means of a powerful hand-press. The position of the type D type of bond when applied is such that the flexible portion occupies that part of the space between the joint-plates where the distance is greatest. No part of the flexible portion extends to the narrow space at the head and foot of the rail. The motion of the rails, due to expansion and contraction or

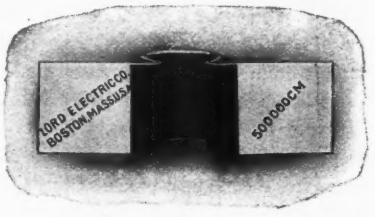


FIG. 4.—TYPE D BOND.

vibration, can cause no injury to the bond by bringing its flexible portion into contact with either the rail or with the joint-plates. This bond can be applied either by soldering or by soldering and bolting.

The type E bond, shown in Fig. 5, was designed for use as a concealed bond under a continuous or Weber rail-joint, where the vertical motion of the rails is limited. The entire length of the bond between terminals partakes in the bending, and the joint will always retain its original shape. The space on both sides of the rail-web is utilized in application, and the

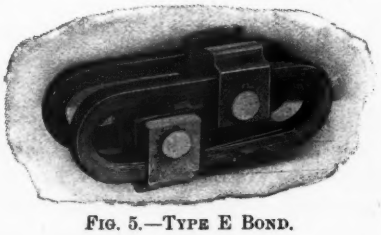


FIG. 5.—TYPE E BOND.

two parts of the bond are riveted together and to the rail, in addition to the soldering.

The *Four-Track News* for February, 1905, is a most attractive publication. The cover is adorned with a reproduction of a California palm and cactus garden, and the frontispiece shows the ice bridge and ice mountain at Niagara Falls, on the New York Central. It is hard to pick out the most attractive contribution to this number, but there is no extravagance in saying that every portion of the issue is well worth perusal.

Jandus Series Alternating Arc Lighting System.

The Jandus Electric Company, Cleveland, Ohio, manufacturer of enclosed arc lamps, has put upon the market a new system of series alternating arc lighting, which has several features of great interest.

FIG. 1.—JANDUS SERIES ALTERNATING-CURRENT ARC LAMP.

The illustrations show the arc lamp, the regulator and a special arrangement of regulator and switchboard panel. These and many details relating to the system are described and illustrated in bulletin No. 21, issued by the company.

The lamp, Fig. 1, is of the widely known Jandus interchangeable type, the casing, glassware and main body being identical with Jandus lamps for all the classes of service now in use, both alternating and direct current, the integrally mounted mechanisms being interchangeable. The interchangeable feature is obviously of great value to central stations using a variety of circuits, as all lamps may be uniform in appearance and structure, with the same inner globes and carbons, and all repair parts identical excepting those forming part of the interchanged actuating mechanisms. The lamp has a differential mechanism, and the regulation claimed for it is very fine. All details are worked out with the same skill and care that have characterized the work of the Jandus company in past years. This lamp won the highest award (gold medal) at the World's Fair, at St. Louis. The long burning life of the lamp—140-175 hours—is specially notable.

FIG. 2.—JANDUS SERIES ALTERNATING-CURRENT REGULATOR.

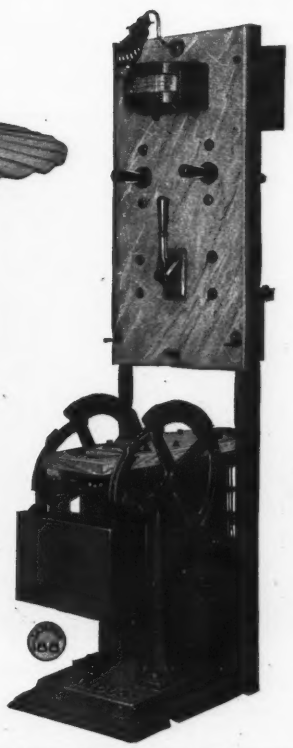


FIG. 3.—JANDUS REGULATOR AND SWITCHBOARD PANEL INSTALLED AS A UNIT.

The regulator, Fig. 2, is perhaps the most interesting feature of the system. It is of the inductive type and is designed on novel lines. It consists of a base-plate and a vertical frame upon which is mounted a heavy marble top. This top carries the terminal binding-posts and supports the inductive coil. The purpose of this construction is to insulate all the current-carrying parts thoroughly from ground. The coil is stationary so that no flexible leads are required. The core is movably mounted to operate vertically into and out of the stationary coil. A weight is connected to the movable core by means of steel chains located in grooved wheels which are mounted on finely finished ball bearings. The weight serves to counterbalance the core when the coil is not energized. Through the medium of an adjustable cam on the counterweight side of this system of forces the moment is made inversely proportional to the magnetic force which actuates the core. The coil is constructed of fine and moisture-proof wire and the insulating heads are of mica, so that the regulator

will withstand a short-circuit for an indefinite period.

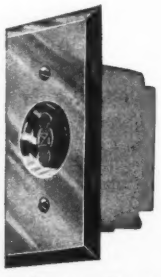
Fig. 3 illustrates a special feature of the Jandus system whereby the regulator and switchboard panel are installed as a unit, which of course may be multiplied in the central station. This arrangement saves largely in floor space, but its particular advantage consists in compacting all the apparatus necessary to be observed and manipulated and in installing it within reach of the attendant. In such an installation the operator has before him and within reach every part of the regulator and every switchboard instrument, so that without changing his position he can make all necessary observations and adjustments in starting the circuit.

The following claims are made as to the advantages of the Jandus type regulator:

Current-carrying parts suspended from marble and thus thoroughly divorced from ground; elimination of frictional retardations by use of perfect ball bearings; fixed coil and movable core, this arrangement requiring no flexible connections which are frequent sources of annoyance; disposition of the counterbalancing weight within the parallelogram of the base, this saving floor space and eliminating the projecting arm, which is often in the way of the station operator; harmony of design with switchboard panel, permitting the installation of the regulator and switchboard as a unit; an indestructible coil capable of withstanding a short-circuit indefinitely.

Some New Snap Switches.

In connection with the new and very complete line of snap switches being put out by the Marshall Electric Manufacturing Company, of Boston, Mass., perhaps one of the most important devices is its



FLUSH ROTARY SWITCH.

flush rotary switch which contains many novel features.

This switch is made to fit the same box as the standard push-button switch. The face-plate is also made to the standard of the national electrical contractors.

One special feature of excellence and novelty is the fastening of the face-plate to the switch body. Heretofore in this class of switch it has been customary to depend upon the handles for holding the plates in place with the result that the plates were usually lop-sided or at an angle with the other finish, in addition to bringing the destructive weight upon the spindle of the switch.

All of these difficulties have been overcome by fastening the plate with screws directly to the back, in the same manner as push-button plates are fastened. This feature is now specified by many electrical engineers and architects. In addition to this, the handle is let into the plate sufficiently to be really flush, so that there is nothing projecting from the face of

INDICATING SWITCH.

the plate. The plates themselves are of novel construction, being cast with ribs or flanges on the back.

The mechanism is hardened steel, insulated by solid sheet mica. All switches are made indicating.

A new snap switch, which is being put in the market by the same company, is illustrated herewith.

This is one of a very complete line which this company is now making. It has several novel features, the most important being the eccentric binding-posts, which give the binding screws an exceptionally long bearing, so that the threads will not strip.

The mechanism is of hardened steel, and is entirely insulated from the circuit by solid sheet mica. The moving contacts are loosely held by the mica insulation so as to more readily adjust themselves to a good bearing in the stationary contacts.

A removable indicating dial is furnished with all 250-volt switches. The lining of the cover is novel, being formed from elastoid fibre in one piece, without seams, wrinkles or roughness of any description. It holds itself in the cover through its own elasticity.

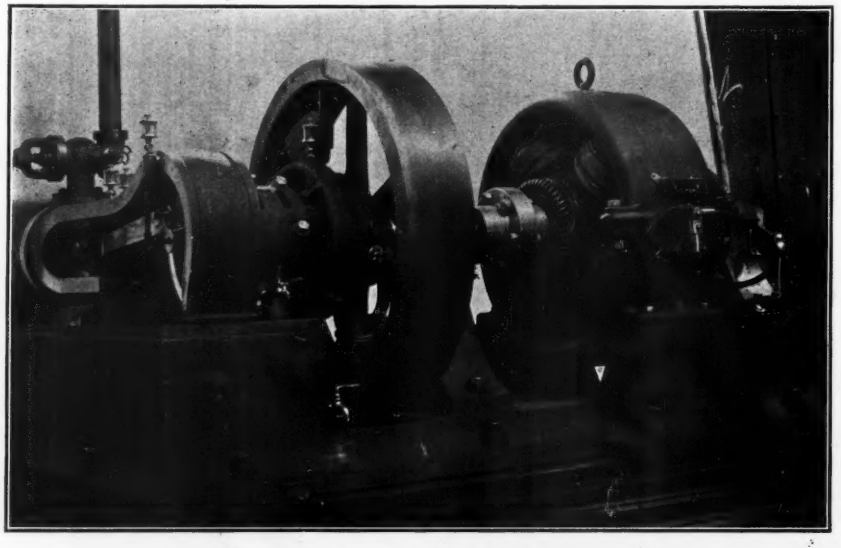
Direct-Connected Generating Set with Horizontal Engine.

The accompanying illustration shows a direct-connected generator of the regular engine type, manufactured by the Ideal Electric and Manufacturing Company, of Mansfield, Ohio. This particular unit has a capacity of fifteen kilowatts at 375 revolutions per minute. It is wound for 110 to 115 volts, and was installed for the Camden City Brewery, of Camden city, N. J.

The generator is the standard type of the company, of which the larger sizes have six poles and the smaller sizes, four poles. The magnet frame is divided horizontally to facilitate handling and ease of repairs, the joints being covered by a rib which adds to the general appearance of the machine. The joints of the pedestal covers are concealed in the same manner.

The field-poles are of wrought iron, fitted with removable pole-shoes of cast iron. The field coils are form-wound and heavily corded for their protection, presenting a neat and striking appearance.

The armature is of the ironclad ventilated type with form-wound coils. Ventilating holes are punched in the discs of the core and intersect with ventilating spaces in the core building. The armature core is built up of annealed sheet-steel discs of the highest electrical quality, the surfaces being oxidized before assembling. The commutators are of rolled copper of rigid construction and of liberal proportions.



FIFTEEN-KILOWATT DIRECT-DRIVEN GENERATOR.

The brush-holders have a parallel movement, are provided with independently adjustable springs, and copper connections between brushes and terminals ensure proper conductivity and perfect contact.

The engine end of this unit is manufactured by the Chandler & Taylor Company, Indianapolis, Ind.

Westinghouse Type K Voltmeters and Ammeters.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., offers a new line of voltmeters and ammeters for switchboard work for use in connection with small installations and in competitive work. They are known as the type K, and are for use upon either direct or

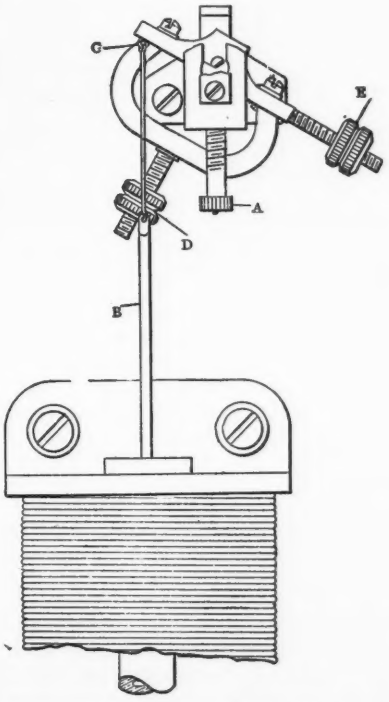
WESTINGHOUSE TYPE K VOLTMETERS AND AMMETERS.

alternating currents. This type is a development of one of the Lord Kelvin patents controlled by the Westinghouse company, and the construction is strictly modern and fulfils the most exacting requirements of present practice.

In shape, size, finish and general appearance, the type K instruments harmonize with the other round pattern switchboard types of the Westinghouse manufacture. The face has a matted surface with raised letters and a pleasing ornamental design in low relief, the entire case being finished in black enamel.

Their principal distinguishing characteristic is the simplicity of their construction. There are but few parts, none of which is complicated and the adjustments are easily made. In effect, the mechanism consists of a stationary coil, through which the measured current flows, the voltmeter measuring the current which flows through a high resistance. This coil acts on a movable core or plunger, which is connected with a steel beam mounted upon knife bearings and carrying the indicating pointer. There are no springs, the action being controlled by gravity. In the type K the core is so constructed that it is saturated with a very small amount of magnetic energy, such as that of one-twentieth full scale deflection, and thus for any load the attraction upon the plunger is directly proportional to the current, making the error due to residual magnetism commercially negligible and the scale almost uniform, commencing with zero. On alternating currents its action is not appreciably affected by changes in frequency. External fields do not influence the performance, and temperature errors are negligible.

The instruments are dead-beat in their indications, the steadying effects of a dash-pot being obtained by inserting the lower end of the plunger in a glass tube filled with oil. The opening in the solenoid is made small and the plunger is a piece of fine iron wire, flexibly connected to the movement by means of a strong silk cord. The only point where friction could be looked for is at the two knife edge



WESTINGHOUSE TYPE K VOLTMETERS AND AMMETERS.

bearings which support the beam, but in fact no frictional effects are perceptible, as the weight is exceedingly light, and the controlling force very great. Movable weights shown at D and E in the accompanying illustration afford a means for adjustment.

The scale has large open divisions which are practically uniform in size, and legible at all points. The sector illustrated at A corrects inequalities by keeping the leverage the same in all positions.

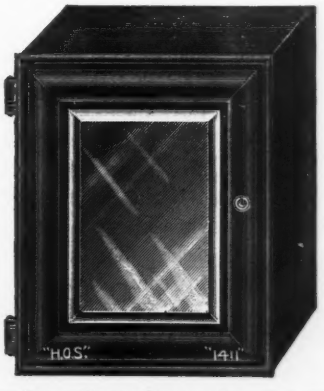
It will be seen that the simplicity of construction gives the type K instruments an unusual degree of strength coupled with exceedingly accurate performance. There is nothing in their mechanism to affect the permanence of calibration, and if by any accident they are broken they are easily repaired and adjustments can be readily made.

Ammeters are regularly made of capacities to and including 1,000 amperes, and voltmeters to 750 volts for use without transformers. For larger capacities, transformers are supplied. Switchboard builders find them of decided advantage in connection with moderate priced panels where high accuracy is desired, such as combination panels for a single generator with its feeders, and small boards for isolated plants.

Panel-Board Cabinets.

The accompanying illustration shows a cast-iron cabinet, style No. 1,411, with beveled glass plate in door, manufactured by the H. O. S. Engineering Company, of Newark, N. J. This cabinet is designed for mounting on the surface of a wall with panel-boards or cut-outs not requiring any side wiring space.

The H. O. S. Engineering Company manufactures a complete line of panel-board cabinets and covers. These are made up of different material and finish, as may be desired. The company has recently moved to a well-equipped factory at 16-22 Boyden place, Newark, N. J. Increased facilities have been secured for the production of panel-boards and panel-board cabinets. In addition to this line of goods, the company has begun the manufacture of the "Falcon" flush receptacle, in accordance with the latest re-



CAST-IRON PANEL-BOARD CABINET WITH BEVELED PLATE GLASS IN DOOR.

quirements of the board of underwriters. It is expected that this material will be placed on the market within a month or so. Bulletin No. 52, describing the increased line of goods manufactured by this company, is now being distributed, and bulletin No. 43 will be ready for distribution in a short time. These bulletins may be had upon request.

The Adams Secondary Generator.

The Adams secondary generator, made by the Wesco Supply Company, St. Louis, Mo., is a practical substitute for primary batteries and can be employed on all low-voltage systems when connected to the secondary side of an all-day alternating current. The amount of current consumed by it is not sufficient to operate the ordinary electric meter and it is therefore operated at practically no expense. It will operate the largest systems of factory signals and can readily be adapted to miniature incandescent lighting. Gas-lighting systems of any size are operated without the use of a spark coil except in cases of "jump" spark systems where the use of high-tension induction coils is imperative. Again, where the bell wiring is so poor or has deteriorated to such an extent that leakage exists which continually permits ordinary batteries to run down, the Adams secondary generator can be installed with the best of results.

The construction is absolutely fireproof and each instrument is tested to 2,000

ADAMS SECONDARY GENERATOR.

volts on short-circuit. It has the approval of the Underwriters' Association in regard to electrical and mechanical construction in every detail, and is pronounced suitable everywhere for use in connection with low-voltage circuits usually operated by batteries where such voltage does not exceed ten volts. Up to this voltage the class of wiring as is ordinarily used in connection with bells is permitted. The construction of generators Nos. 1 and 2 is electrically and mechanically such that it is impossible to overheat or injure the generator proper or any of the wiring of the system in connection with the secondary side in any way, should short-circuit occur from any cause. The distinguishing feature of this instrument is its inherent self-regulation by which the maximum output of the generator is automatically limited so as to prevent any possibility of harm to the instrument itself, or to the secondary wiring system in connection with it, under even extreme cases of short-circuit. Should a short-circuit occur the voltage of the machine at once drops to nearly zero, thereby restricting the amount of current flowing to a point where it is incapable of overheating any conductor whatever.

The secondary coils of each instrument are provided with three terminal posts from which three different voltages can be drawn as desired. The two posts at the left supply the lowest pressure, the middle post and the one to the right, a medium pressure equal to twice the former, and the two outside terminals supply a voltage equal to three times that of the first position. Automatic annunciators and, in general, all devices having several coils in series, and consequently being possessed of considerable self-induction, are usually operated best on alternating current when the higher voltage is made use of. In any event, with three different potentials to select from, the one most suitable for any given case is readily obtained.

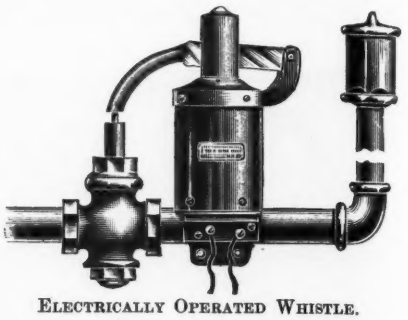
The all-day loss of this instrument represents an effective current value at 100 volts of one one-hundredth of an ampere or about the sixtieth part of the current required for a single sixteen-candle-power lamp which at once becomes a negligible quantity, since it is far from sufficient to start, or, when started, even to move a recording wattmeter.

The generator is designed to be connected to the 110-volt or secondary side of alternating currents, as shown in the connecting diagram accompanying each instrument. The installation is a simple matter requiring little work. The bells, however, require slight adjustment so that they will operate on alternating currents of either frequency.

While the generator will operate on the secondary of any alternating current, it is necessary that the generators have the same alternations as the electric current used. Bells must be wired in multiple and adjusted according to the number of bells it is intended to use, and the different voltages of the machine applied according to the resistance of the circuit.

An Electrically Operated Whistle.

The Electrical Appliance Company, 132 Longworth street, Cincinnati, Ohio, is placing on the market a device which will electrically operate a whistle situated in any position, by simply pushing a button close at hand. The whistle may be placed either indoors or outdoors, and any required distance from the operating key. The standard type of whistle for all ordinary pressures of steam is shown in the illustration. Any voltage of direct or alternating current may be provided for in the winding of the actuating solenoid. The device will operate any whistle up to three inches in diameter at 150 pounds pressure. If provided with a larger valve it will operate a six-inch whistle at the same pressure. A recently developed use for this apparatus is in connection with private branch telephone exchanges. It enables the operator to reach parties whose duties require their presence in many places remote from the office. Any number of different signals may be arranged,

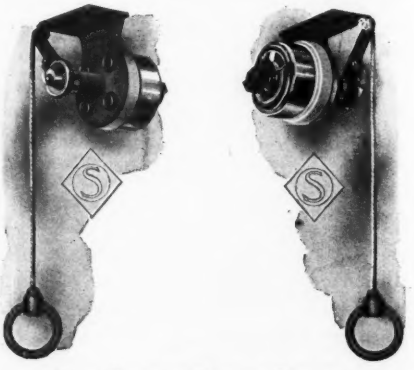


ELECTRICALLY OPERATED WHISTLE.

so as to reach as many different men. If a call comes in for any particular man, the operator presses the whistle key the requisite number of times, thus giving the signal on the whistle for that particular man. The latter then goes to the nearest telephone and calls the operator, who then connects him to the calling party. In this way no time is lost in hunting him up and bringing him to the telephone.

A New Form of Ceiling Switch.

A new form of ceiling switch has been placed on the market by P. Sorensen, 45 York street, Brooklyn, N. Y. As may be seen from the accompanying illustrations, this switch is peculiarly simple in design and construction. The switch is built with the usual snap switch rod, the rod, however, being extended through the back

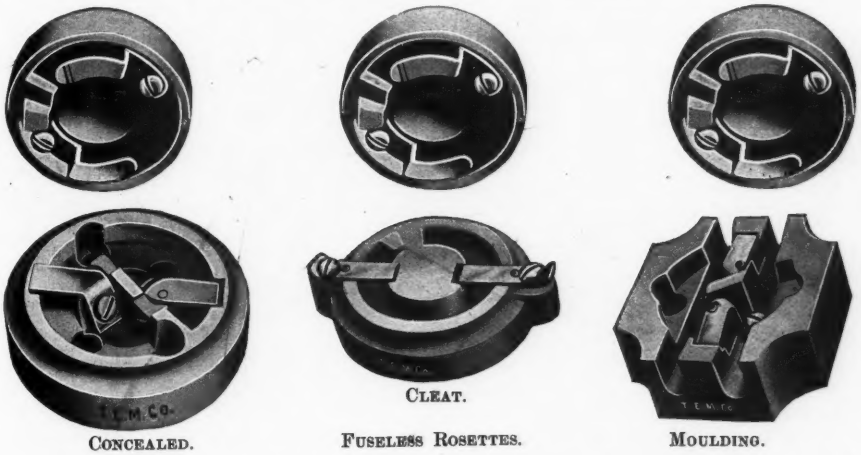


NEW FORM OF CEILING SWITCH.

of the switch case which is mounted upon a right-angled bracket. A lever with ratchet and pawl is fastened to the end of the switch rod. The pawl and lever are actuated by a cord which is made long enough to be easily reached from the floor. A spring brings a tension on the pawl, and always returns it to its normal position. The switch is opened by one pull, and closed by the next pull. The device is intended for installation in out-of-the-way places, and is a modification of the regular snap switch.

Fuseless Rosettes.

The Trumbull Electric Manufacturing Company, Plainville, Ct., manufactures the fuseless rosettes which are shown in the accompanying illustrations. The rosettes are made with spring tongues and caps, and the cord may be applied and the rosettes snapped on after the base is in position. The stop in the cap allows it to be put on in one way only. This is a particularly valuable feature for arc light work, as there is no possibility of reversing the current by taking off the cap. The caps are interchangeable and will fit any style of base.



CONCEALED. FUSELESS ROSETTES. CLEAT. MOULDING.

The Westinghouse-Parsons Steam Turbine.

The Westinghouse-Parsons steam turbine is described and illustrated in a handsome booklet which has been issued by the Westinghouse Machine Company, of Pittsburg, Pa. The first few pages of the book are devoted to a history of the steam turbine, of its origin and development from Hero's engine about 120 B. C. to the present Westinghouse-Parsons machine. A discussion of the action of steam in the turbine, together with the principle of the turbine, follows. The construction of the turbine and of turbine generators is treated, and is illustrated by half-tones of the different parts of the machine. Half-tones of a number of recent installations are also shown. In the back of the book are some very valuable data, in the shape of results of tests of a 400-kilowatt, a 750-1,000-kilowatt and a 1,200-kilowatt turbine, under varying conditions.

Eastern Carbon Works Products.

Knowledge gained in producing high-class goods for many years is of real value. Designs and formulas, each for their special purposes that have been tested by thousands of patrons, and faults discovered and corrected, form a strong basis for confidence. It is only gradually that good batteries and carbons are evolved. That they give a maximum output is because experience has shown how to make them effective. The Eastern Carbon Works, of Jersey City, N. J., for nearly twenty years have been favorably known as manufacturers of wet and dry cells, carbon brushes and carbon products of every description. Their batteries of all kinds are standard and up to date.

Carbon brushes are made in many varieties by this concern. Besides the high grade combination wire and carbon, the different grades of graphite and regular brushes, they have recently produced and patented a brush that is designed to break up the eddy currents that work injury to the contact end of the brush. To accomplish this they use their ordinary grade of carbon in the centre, as a conductor, and integrally mould with it on each side (heel and toe) a material of high resistance which successively breaks up the useless currents. Several large manufacturers have adopted it after exhaustive tests.

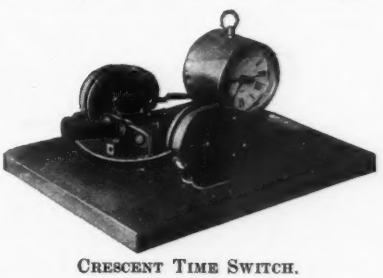
The accompanying cut shows the new Eastern battery connector, which was exhibited at the recent automobile show in New York, and for which a patent has been applied for. The rubber fastened securely to the terminal is compressed by the screwing up of the nut, and the spring in the rubber forces the nut back and jams it against the threads of the screw, so that no amount of vibration can jar it loose. It was designed originally for automobiles, but can be used to good advantage in any place where the vibration is excessive, as in automobiles, launches, steamboats, railroad trains, trolley cars, switchboards, etc. The company also furnish the terminals without the wire and make them in all sizes.

BATTERY CONNECTOR.

The Crescent Time Switch.

The Crescent Company, Chicago, Ill., has placed on the market a new form of time switch for automatically cutting out one or a series of window lights. One of the inconveniences of the merchant who does not keep his store open after dark is the necessity of making a call after the closing time to shut off the window lights. If this is not done it is a question either of leaving the lights on all night or of not having a store front and windows properly illuminated, so that the attention of buyers may be attracted during the evening hours. The new time switch is made in two sizes. The type "A" only turns off the lights, while the type "B" turns the lights both on and off.

The type "A" time switch consists of a polished slate base, upon which is mounted a high-grade Parker clock. There is also mounted upon this base a standard high-grade knife switch, which is operated by a strong, reliable spring entirely separate from the clock. The clock simply trips the spring at the specified time. The switch is thrown out of service opening the circuit. The switch is simply installed on the circuit, and is used as an automatic switch for the shop window. All that is necessary is to set the clock for the specified time, the same as for the ordinary alarm clock.



CRESCENT TIME SWITCH.

The type "B" switch is of similar design, and is made with two clocks mounted upon a slate base. With this device the user can have the lights burning for any specified time, throwing the lights on and then cutting them out as desired.

The Pease Blue-Print Washing and Drying Machine.

The accompanying illustrations show a new form of blue-print washing and drying machine manufactured by C. F. Pease, 180 West Locust street, Columbus, Ohio. This machine is designed for the purpose of reducing the cost of producing large quantities of blue-prints, and to do away with the large washing tanks and drying paraphernalia usually incident to blue-print work.

The washing of the prints is accomplished by a spray of running water flowing over the treated side of the paper only. This removes the surplus ferro-prussiate in the quickest time possible. The prints are not soaked through, the water coming in contact only with one side of the paper, and but for a short time. This makes possible a very much increased rapidity of drying.

The print is placed on the drying rod before washing, and remains there during the entire process of washing, wiping and drying. As the print hangs in the washing tray on the drying rod, the water flows down both sides of the doubled print—half of it on the side toward the operator, and the balance between the print and the back of the tray. When the front portion of the print in view of the operator is completely washed, the balance is always in the same condition.

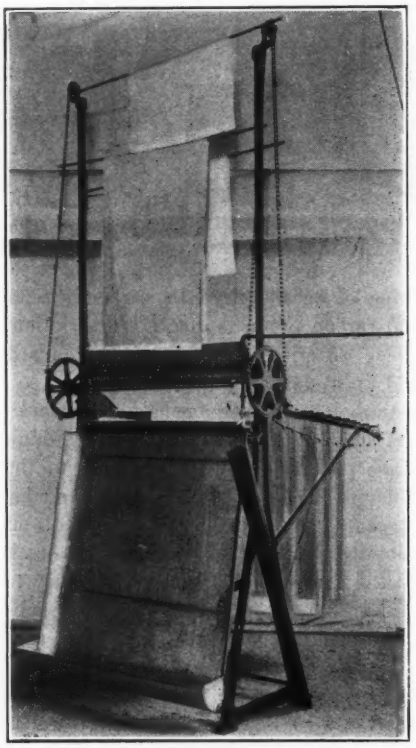
The surplus water is removed by a device which wipes the print as it is moved upward out of the way in the drying chains. As the following print is pulled through the wiping device, the previous one is carried still higher, and over the top, and finally down until it is automatically stripped from the chains of the machine and placed in a drying rack; then removed as required.

The construction of the machine is easily seen from the illustration. It is a rigid, light cast-iron framework, thoroughly braced, and supports the washing, dripping and drying devices, making it completely self-sustained and portable.

The washing tray, guard and pan are made of extra heavy galvanized iron, reenforced and supported by galvanized malleable iron fittings. The upper frame, carrying the small sprockets and chains, is of iron tubing, well braced and secured to the main frame of the machine, and provided with adjusting screws for adjusting the chain.

The spray is forced through a brass tubing properly guarded by a copper shield to direct the water where required. The drying rods are made of the best air and kiln-dried maple, and are varnished, polished, metal-tipped and provided with rubber separators. There is a sufficient number of drying rods to meet any requirement.

The machine is finished in black enamel, and the bright parts are nickel-plated. The apparatus is made in four sizes—E, F, G and H, taking maximum prints of the following sizes, respectively: twenty-four by forty-eight inches; thirty by sixty-six inches; thirty-six by eighty inches, and forty-two by one hundred inches. Size H was designed for large blue-print manufacturers, and is provided with a special racking device which keeps the prints separated and accommodates a much larger number at one time. This



BLUE-PRINT WASHING AND DRYING MACHINE WITH SPACING ATTACHMENT.

device can be applied to other sizes when required.

Quick delivery of prints can be secured by the addition of a heater, which Mr. Pease is prepared to furnish. This heater may be placed at the rear of the machine, and will accelerate the drying of the prints. The heater is constructed to use either artificial or natural gas, and may be applied at any time.

An automatic drying rack has been designed, to be applied where the size and quantity of blue-prints will not permit their drying entirely before delivery in the regular rack at the rear of the machine. This automatic drying rack can be applied to any size of machine at any time. The rack automatically removes the blue-prints from the main chains of the machine, and maintains a uniform distance between them until they reach an accumulating rack at the end of the travel of the endless chains.

Comparative Test of a Small Boring Mill with and without Maintained Cutting Speed.

The American Electric and Controller Company, 12 Dey street, New York city, recently made a test of a thirty-one-inch boring mill equipped with its new "Rheocrat" controller. The boring mill had a single pulley drive and a four-change-gear speed box. It was driven by a five-horse-power, shunt-wound, constant-speed motor. By the addition of the "Rheocrat" the mill had over 144 changes of speed. The two following tables show the relation of speeds obtained by the "Rheocrat" controller. Those obtained through the gear box are designated "mechanical," and those obtained through the "Rheocrat," "electrical" changes.

MECHANICAL CHANGES.

(Driving shaft running 270 revolutions per minute.)

Back Gears (4½ to 1) in.	Turns of Table per Minute.
First gear	3.6
Second gear	5.4
Third gear	7.2
Fourth gear	10.8
Back Gears Out.	
First gear	16.2
Second gear	24.25
Third gear	32.4
Fourth gear	48.6

One-quarter minute required to make any one of the above changes.

ELECTRICAL CHANGES.

(Driving shaft running 112 to 450 revolutions per minute.)

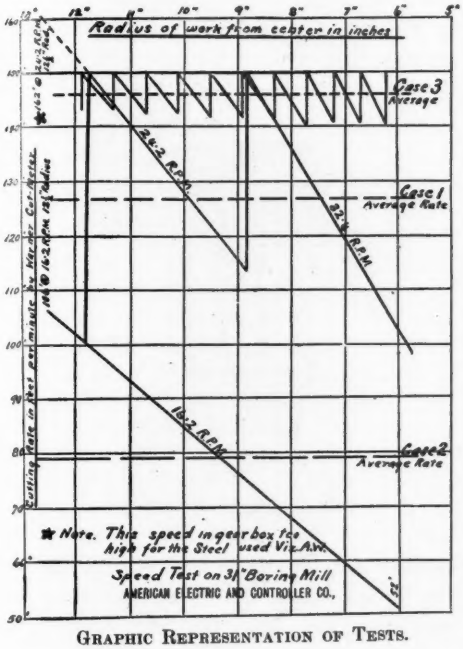
Back Gears (4½ to 1) in.	Turns of Table per Minute.
First gear	1.5 to 6
Second gear	2.25 to 9
Third gear	3.0 to 12
Fourth gear	4.5 to 18
Back Gears Out.	
First gear	6.75 to 27
Second gear	10.1 to 40.5
Third gear	13.5 to 54
Fourth gear	20.2 to 81

No measurable time lost making changes.

In a test made on a twelve-inch pipe flange twenty-five inches outside diameter the following figures were obtained. "A.W." steel was used, and the grade of iron was such that 150 feet per minute cutting speed was found to be the maximum with this steel. The object of the test was to keep the cutting rate as near as possible to the maximum. To finish the flange a roughing and a finishing cut were taken. In the first test the mill was operated by the motor without the use of the "Rheocrat." The shaft ran at a constant speed of 270 revolutions per minute, with the back gears out. Speed changes were made by shifting the change

gears in the speed box. The maximum cutting speed was 150 feet per minute; highest average possible, 127 feet per minute; actual time of cutting, 3.9 minutes; time lost in changing gears, 1.2 minutes for roughing cut; time lost in reversing feed, 0.5 minute; total time required to make two cuts, 10.7 minutes; time lost in taking out work and resetting another casting, five minutes, making the total time required to face a flange 15.7 minutes.

Test No. 2, mill operated by motor without the use of "Rheocrat." Shaft running at constant speed 270 revolutions per minute. Back gears out. No changes were made in the gearing on


Radius of work from center in inches
Case 3 Average
Case 1 Average Rate
Case 2 Average Rate
Cutting Rate in feet per minute
* Note. This speed in gear box too high for the Steel used Vic. Ave.
Speed Test on 3' Boring Mill
AMERICAN ELECTRIC AND CONTROLLER CO.

GRAPHIC REPRESENTATION OF TESTS.

the supposition that the average shop mechanic would not make them. Maximum cutting speed, 150 feet per minute; highest possible average, 79.11 feet per minute; actual time of cutting, 6.35 minutes for one cut; time lost in reversing feed, 0.5 minute; total time required to make the cuts, 13.2 minutes; time lost in taking out work and resetting another casting, five minutes; total time required to face a flange, 18.2 minutes.

Test No. 3, mill operated by motor and "Rheocrat." Range of speed secured on the driving shaft, 112 to 450 revolutions per minute. The back gears were out. The machine was adjusted to the proper speed by combined "Rheocrat" and change gear variation, but the "Rheocrat" variation alone was used during the cut. Maximum cutting speed, 150 feet per minute; highest possible average, 146 feet per minute; actual time of cut, 3.45 minutes; time lost in changing speeds, none; total time, 3.45 minutes, plus 0.5 minute for reversing feed, equaling 3.95 minutes; time for two cuts, 7.4 minutes; time lost in taking out work and resetting another casting, five minutes; total time required to face each flange, 12.4 minutes.

The accompanying diagram shows the above tests graphically. On a day of eight hours continuous work, with conditions as in test, the daily output will be thirty flanges, and thirty-eight flanges with conditions as in test 3. This is a gain of practically twenty-eight per cent in the output.

Comparing test No. 2 with test No. 3, and allowing eight hours continuous operation per day, the use of the "Rheocrat" shows a gain of over forty per cent, the actual number of flanges being twenty-seven and thirty-eight, respectively.

"The Insulator Book."

The Locke Insulator Manufacturing Company, Victor, N. Y., has issued a valuable catalogue entitled "The Insulator Book." In issuing this catalogue it is the idea of the company to bring before the engineering world the types of insulators which are recognized as best adapted to the service conditions of various climates. The endeavor has been to eliminate all designs which have proved to be defective, and to simplify and bring to standard form insulators for ordinary potentials of transmission. The company recently added to its equipment a laboratory for electrical and electrochemical research along the special lines required for a positive and accurate development of high-potential insulators. It is the intention to make a more thorough study than has before been attempted of insulating materials for extremely high potentials, and of insulator design.

The laboratory is of full fireproof construction, measuring twenty by forty-eight feet. The foundations and floor are of heavy concrete design, to carry the heavy machinery without communicating vibration to any delicate apparatus. The electrical equipment includes a transformer with a guaranteed capacity of 200 kilowatts at 300,000 volts. This transformer is of the core type, with approximately ten by ten inches cross-section of iron, and has a primary wound for 1,100 volts. The secondary consists of approximately forty-two miles of No. 26 wire, which, under oil, will carry a 100-per-cent overload for considerable periods of time, and at an overload potential of 400,000 volts. This transformer is the most powerful electric testing equipment in present use.

Current for the primary of the transformer is provided by a motor-generator set, power for which is obtained from a local transmission line. This set consists of a 440-volt, three-phase, twenty-five-cycle, 200-kilowatt induction motor, direct-connected by a flexible cable to a sixty-cycle, 1,100-volt, single-phase generator of similar capacity.

To facilitate measurements of secondary voltages, a spark-gap, adjustable by hand, is provided, with a scale calibration of 480,000 volts, enabling tests of any material to be made. For more accurate measurement of the high voltages a secondary voltmeter has been installed. This instrument, submerged in oil, transfers its readings by means of a mirror to a calibrated scale, which is read by means of a telescope. The very small secondary coils are measured by means of an inclined-coil instrument inserted at the point of earth potential of the secondary winding.

An experimental pole-line has been erected for some distance from the laboratory, and this is equipped with standard poles and cross-arms adapted to receive any style of pins or insulators, whose distances apart may be varied.

A simple form of dynamometer provides facilities for the testing of tensile and crushing strength of insulators and insulating materials. For the study of very refractory substances an electric furnace capable of absorbing 200 kilowatts is provided.

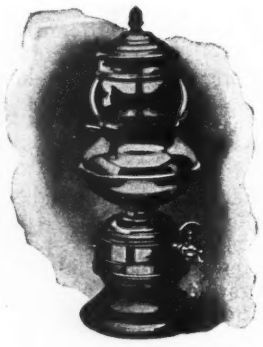
The catalogue describes the methods of making insulator tests, giving a table of standard sparking distances. It then describes and illustrates porcelain insulators, including strain insulators, sectional strain insulators, wall insulators, wall tube-insulators, high-voltage porcelain tubes and flare tubes. There is also described a line of flint-glass insulators and insulator pins and brackets.

"Pointers."

The American Vitrified Conduit Company, Broadway-Maiden Lane Building, New York city, has published a handsome brochure under the title "Pointers." It is intended to give such information as may be required for preliminary estimates in laying out plans for conduit work. A diagram is given showing, approximately, construction costs for conduit work, taking into consideration, cobble or macadam, belgian blocks or brick, and asphalt pavement. This diagram is compiled from data covering a large amount of conduit work under varying conditions. The duct made by the company is described and illustrated, and lists of corporations and contractors using this material. The brochure is mailed in a heavy decorated envelope and may be secured by writing to the company.

Prometheus System of Electric Heating and Cooking.

There is, perhaps, no better illustration of the great flexibility of the electric current for commercial and domestic purposes than its use after it has been transformed into heat. The numerous advantages of electrically equipped heating and cooking apparatus, such as the riddance of smoke and soot, no vitiation of the atmosphere, instant heat at the exact place where it is wanted, no fuel or large cooking range, no labor in making or maintaining the fire, no waste of heat, perfect regulation of temperature, no danger from fires or explosions, cleanliness, etc., have all been recognized by those interested in the introduction of electricity into home and workshop for a number of years, but well-grounded causes are responsible for the somewhat limited but nevertheless



ELECTRIC COFFEE POT.

growing use of electrically equipped cooking and heating apparatus.

Primarily, the rate charged for current has been almost prohibitive, but it is being constantly reduced on account of the improvements in general machinery, the extension of the central station system of distribution, the increase in the number of water power and isolated plants and because central station managers are beginning to realize the fact that electric heating apparatus are current consumers during those hours of the day when their station load is light.

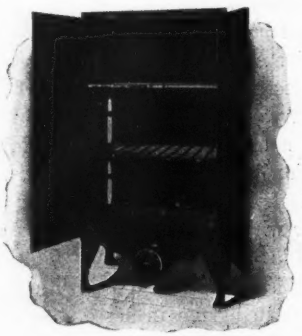
The householder also has become accustomed and attached to things electrical and is willing to supplant his gas stove by an electric stove or electrically heated pot, similarly to his willingness some years past to substitute the gas stove for the coal range. To do the requisite work with such utensils, excepting, perhaps, the iron, current costing in most cases less than one cent is consumed.

In the "Prometheus" system no wires are used. The heating device itself consists of a strip of mica on which a layer of metal has been deposited, or, more properly speaking, fired. This conducting strip is protected by another piece of

TWO TYPES OF PROMETHEUS ELEMENTS.

mica, and the whole is enclosed in a metallic casing. This unit or "heating element" can be painted to any desired resistance. The paint is an alloy composed of non-oxidizable metals, ensuring the element's life. The element may be either straight or circular according to its usage, and may be inserted into or removed from a piece of apparatus with the greatest ease by an unskilled person in case of a breakdown; an advantage heretofore denied by any other known method.

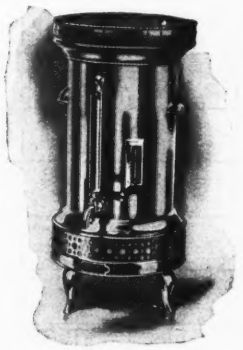
As stated above, in the "Prometheus" system, the utensils themselves are equipped with the heater, thus dispensing with a stove, which means not alone the purchase of one piece of apparatus, say, a pot or chafing-dish, instead of a pot or chafing-dish and stove on which to place it, and by actual tests it has been shown that eighty-seven per cent of the heat sent into a utensil is utilized therein for the heating of the food. This may be



ELECTRIC PLATE-WARMING CLOSET.

illustrated by the fact that a pot in which water is boiling may be held in the palm of the hand, showing that the heat does not escape, but is retained in the pot, the only place where it is wanted. This in turn means not alone a saving of time, for the greater heat ensures quicker action, but if a gain is no object, less current is required to do the same work as that done by any other method in which a stove is used. The latter, as is well known, is a very inefficient piece of apparatus, which only transmits about thirty per cent of the heat generated in it to the food in the cooking utensils. The remainder of it escapes into the surrounding atmosphere, goes up the chimney and heats up the stove itself and the air space between it and the utensils.

The system was first developed in Europe, and has been in exclusive and successful use in Germany for ten years. In Austria, the well-known Siemens & Halske Company has introduced the system, and in Switzerland, England and France it is extensively used for domestic and commercial purposes, being exploited by

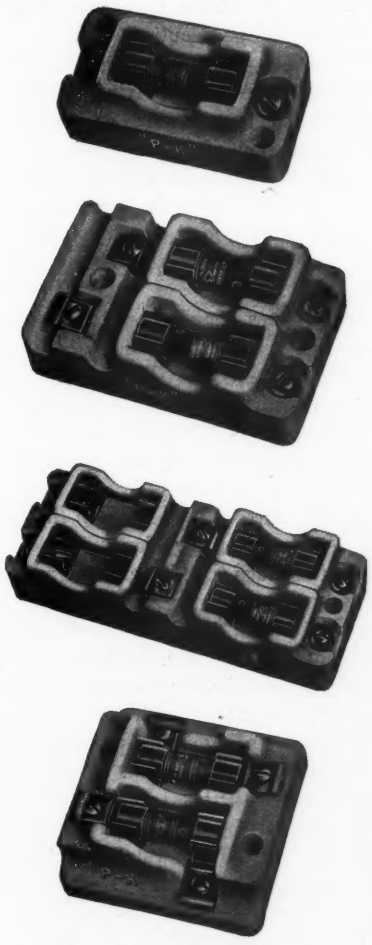


ELECTRIC COFFEE URN.

separate corporations in each country. In the United States, the Prometheus Electric Company, 41 Cortlandt street, New York, has developed during the past three years a line of apparatus suitable for this market, and a number of these are shown by the accompanying illustrations. These utensils, possessing all the merits referred to above, have found great favor everywhere and are being handled by every large supply house and central station selling apparatus. A successful demonstration is being conducted at the department store of R. H. Macy & Company, New York, which was illustrated in the issue of the ELECTRICAL REVIEW for January 14. All the ticket and toilet-room heaters in the New York subway are of the Prometheus type, and the steamships "Minnesota" and "Dakota," the Berg hat factory, and numerous other factories are equipped with this unit system of heating. The company's literature will be sent to any one on application.

Cartridge Fuse Cutouts.

A new line of cartridge fuse cutouts has been placed on the market by the H. T. Paiste Company, Philadelphia, Pa. They are made according to the new code



CARTRIDGE FUSE CUTOUTS.

standard with capacities of from three to thirty amperes, and take the new code "ferrule" type fuses.

The contact clips are of special spring bronze, so formed as to make perfect contact with the fuse ends. It will be noticed in the illustration herewith how each fuse is placed safely in its own compartment, which is so designed that accidental short-circuiting across the spring clips or the ferrules of the fuses is impossible.

Eight styles of these cutouts are made, which correspond with similar styles of the familiar plug cutouts. The plug cutouts are numbered, but a "7" is prefixed to each one, so that the new numbers will be entirely familiar. A folder giving prices and discounts will be mailed to any person interested upon request.

Motor-Starting Panels for Constant-Speed Motors.

The Ward Leonard Electric Company, Bronxville, N. Y., is placing on the market a motor-starting panel for direct-current, constant-speed motors. Each panel consists of a marbleized slate base at least three-quarters of an inch thick. On this panel are mounted one overload and a no-voltage release, a motor starter, one double-pole, single-throw switch, and two enclosed fuses. The overload release is a circuit-breaker, and will protect the motor during the period of starting, as well as in its running position. The no-voltage release magnet responds solely to the line voltage, and is entirely independent of the field or armature current.

To prevent arcing upon the first live contact, there is furnished an independent spring-actuated renewable circuit-closing switch, which breaks the circuit with a quick break in all sizes, and with a quick break and magnetic blowout on sizes above ten horse-power. The stationary contacts are all in segmental form, and are readily removable and renewable.

MOTOR-STARTING PANEL.

The starting lever contact is of the self-aligning, renewable, skate-shoe type. The starter will stand, without injury or alteration, a current of fifty per cent in excess of the full load motor current when passed through the entire resistance when cold for one minute. It also will stand, without injury or alteration, a current which is double the full load motor current when passed through the entire resistance when cold for twenty seconds. It is so built that it is impossible for it to take fire if the resistance is burned out by overload current. This panel has been installed in the Hotel St. Regis and the Hotel Astor, New York city, and in many other hotels, machine shops and factories.

Changes in Allis-Chalmers Sales Office Organization.

The Allis-Chalmers Company, Milwaukee, Wis., announces a number of important changes in its sales office organization throughout the country. These changes are brought about because of the broadened scope of the company's operations since it acquired the Bullock Electric Manufacturing Company, Cincinnati, Ohio, which has now become the electrical department of the Allis-Chalmers Company. It will hereafter be the rule that each Allis-Chalmers district sales office will represent all the company's lines of manufacture in prime movers, as well as in sawmill, flour-mill, mining, crushing, cement and other machinery and the electrical interests. This policy involved the opening of a number of new offices by the Allis-Chalmers Company, and in many places the consolidation of Bullock offices which have heretofore been maintained in the same centres. Following out this policy, some recent changes have been made, as follows:

An Allis-Chalmers district sales office has been opened in St. Louis in the Chemical Building. The Bullock Electric Manufacturing Company's offices, formerly in the same building, have been consolidated with them. Mr. H. P. Hill, formerly district manager for the Bullock company, is the manager for the consolidated offices.

An Allis-Chalmers Company district sales office has been established in Cleveland, in the New England Building, where the Bullock offices formerly were, and the two offices have been consolidated under the new management of Mr. Franklin Wharton, formerly district manager for the Bullock company.

A Bullock office has been opened in the Frick Building in Pittsburg, and consolidated with the Allis-Chalmers office under the management of Mr. H. Wiedman Murray, who has for years represented the Allis-Chalmers Company in that district.

The Allis-Chalmers Company has established a new office in Kansas City in the Dwight Building. Mr. George W. Mattison, who has been connected with the company for a considerable time in other capacities, is in charge.

An Allis-Chalmers district office, with temporary headquarters in the Ellicott Square Building, has been opened in Buffalo under the management of Mr. George W. Pulver. Mr. Pulver is well known throughout the district of which Buffalo is the centre, having been for a number of years with the Westinghouse Electric and Manufacturing Company at its Syracuse office, and acting manager of that office until recently.

Annual Convention of the Officers and Branch Managers of the Crocker-Wheeler Company.

The annual convention of officers and branch managers of the Crocker-Wheeler Company took place at Ampere, N. J., at the main office and works, on January 26, 27 and 28. As the company has recently entered the alternating-current field, the most important topic discussed at the convention was alternating-current design and construction. Chief-engineer Gano S. Dunn and Messrs. Edward Heitmann and H. Pikler, of the engineering department, lectured to the branch managers on this subject. This was the first opportunity for some of the branch managers to discuss these matters personally with members of the engineering department. Messrs. Dunn and Heitmann also informally told of their recent trip to San Francisco, where, a short time ago, an order was closed with the California Gas and Electric Corporation for three 4,000-kilowatt-amperes alternating-current generators, the largest gas-engine-driven generators in the world.

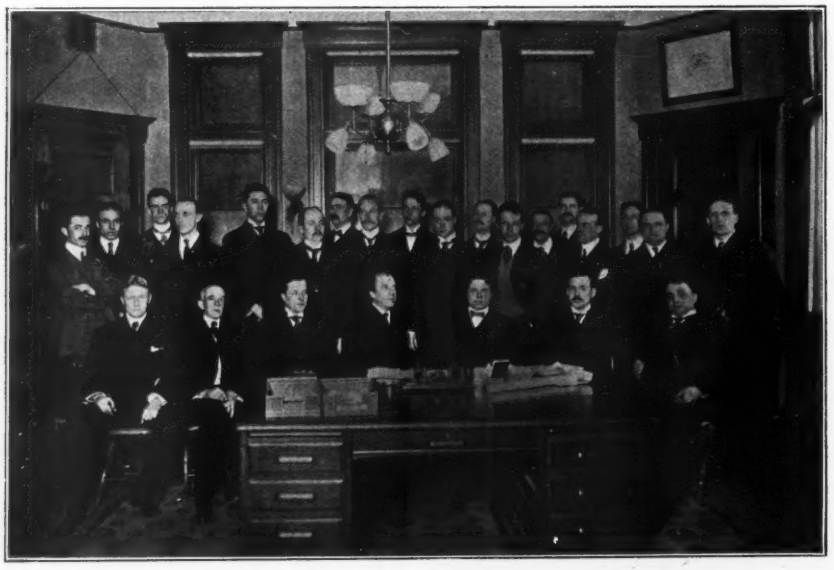
Another subject which received a good deal of attention was the new field-weakening motor, recently put on the market by the company. The office managers throughout Ohio were particularly interested in this subject, as this new motor is designed very largely for driving machine tools.

On the evening of January 27 a banquet was given at the Café Martin, in New York, at which President Schuyler Skaats Wheeler presided and Secretary A. L. Doremus was toastmaster.

In the accompanying illustration the men are as follows, beginning at the left:

Top row: Messrs. J. R. Wilson, Rodman Gilder, R. B. Treat, H. C. Baker, H. C. Petty, S. Russell, Jr., W. A. Doble, Harold Lomas, Hugh A. Brown, F. B. Degress, R. N. C. Barnes, Leonard S. Horner, H. S. Pikler, C. W. Gearhart, Louis M. Ward, H. M. Gassman, Wm. F. Sullivan and E. Heitmann.

Second row: Messrs. Henry J. Sage, W. L. Brownell, treasurer, H. L. Patteson, A. L. Doremus, secretary, Dr. Schuyler Skaats Wheeler, president, Gano S. Dunn, vice-president, and Julian Roe.



OFFICERS AND BRANCH MANAGERS OF THE CROCKER-WHEELER COMPANY.

Incandescent Lamp Filaments.

A quarter of a century ago the incandescent lamp became a practical part of an electric lighting system. In 1878, Mr. Albon Man, of Brooklyn, became associated with Mr. W. E. Sawyer, of New Hampshire, in a patented lighting system, as a part of which was described "a lamp of our invention—in which a small piece of carbon is heated to incandescence in an atmosphere with which it will not combine." In March of that year these gentlemen set up a shop in New York city for experimental purposes, and shortly afterward produced a number of lamps in which the filament was made of slips of paper carbonized by being packed in graphite and heated to a suitable temperature. Afterward the carbons were placed in flasks filled with hydrocarbon vapor and brought to a dull incandescence in a low-tension current. This process was called "treating" the filament, and continues to-day as one of the most important processes in the manufacture of an incandescent lamp.

Various substances such as cotton thread paper, and wood fibres of different kinds and from many countries were used as a basis for carbon filaments; filaments cut from the hard outside shell of a certain variety of bamboo and carbonized at a high temperature giving the best results, until later researches resulted in the production of the cellulose filament.

Cellulose, which has a chemical formula of $C_{12}H_{20}O_{10}$, exists in many forms of woody fibre, the most convenient of which for our purpose being ordinary cotton wool. A solution of this is squirted through dies having small apertures, emerging in fine threads, which after washing, drying and forming are packed in fine sawdust in crucibles which are then subjected to the intense heat of a furnace for some hours until the hydrogen and oxygen of the cellulose have been liberated, leaving the carbon in the familiar jet black springy filaments.

At this stage the filaments are as nearly uniform in diameter as mechanical skill can make them, but if subjected to a low-tension current it will be found that certain parts of the filament are of smaller diameter than the rest, and having in consequence a higher resistance will burn at a higher temperature. Now if this action be permitted to take place in an atmosphere of hydrocarbon vapor at a pressure below the normal the vapor will be decomposed, carbon in graphitic form being deposited on the surface of the filament in direct ratio to the heat generated. The points of smaller cross-section being at a higher temperature decompose the vapor more rapidly than does the rest of the filament, and so are built up by the deposited carbon, with resulting uniformity throughout its length. In addition this after-treatment gives the surface of the filament a metallic lustre resembling polished steel, which radiates heat less readily than the jet black surface of an untreated filament, and consequently for a given expenditure of electrical energy a larger amount of carbon can be kept hot with an increased efficiency of the lamp.

This process is that described as having been made use of by Sawyer and Man in treating filaments early in 1878, since developed and improved by the manufacturers of this lamp, until brought to a state of perfection where with skill in inspecting, measuring, and selecting, every lamp of a certain class sent out from the Sawyer-Man factory is absolutely uniform in characteristics with every other lamp of that class.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

THE GREAT NORTHERN POWER COMPANY—The Great Northern Power Company, Duluth, Minn., has filed articles of incorporation with a capital of $8,000,000. The company will utilize the water power of the St. Louis river. J. T. Fanning, of Minneapolis, Minn., has been retained as consulting engineer, and is associated with W. A. Breckenridge, superintendent of the Niagara Falls power plant.

ALABAMA RAILROAD TO MAKE LARGE EXTENSIONS—The Birmingham Railway, Light and Power Company, Birmingham, Ala., has authorized the expenditure of about $250,000 for improvements to its system of light, heat and power plants. Several new viaducts will be built to improve the railroad system, and at Bessemer, Ala., $10,000 will be spent on a new terminal station. This will be built for passengers and freight. The track between Powderly and Bessemer will be relaid at an expense of about $20,000. New cars will also be added to the present rolling stock.

NEW OHIO POWER PLANT—The Columbus, Delaware & Marion Electric Railway Company is shortly to erect a new power plant near Delaware, Ohio. The growth of this road has been so rapid that the demand on the existing power station is in excess of the capacity. Three new 1,500-horse-power generating units have been contracted for. An expenditure of $300,000 has been authorized, and the work is to be undertaken by the Columbus Northern Power and Equipment Company. Additional rolling stock will also be purchased to handle the increasing business.

COLORADO POWER PLANT NEARLY COMPLETED—The power plant of the Animas Canal, Reservoir, Water Power and Investment Company, located on the Animas river, between Silverton and Durango, Col., is almost ready for operation. The capital of the company is $3,000,000. Work on the plant was begun in the summer of 1902. It is expected that the company will be ready to supply power by July 1. The power station will contain two General Electric generators, each connected with a turbine water-wheel. The generators are of the three-phase, sixty-cycle, revolving-field type, of 3,000 horse-capacity each.

POWER PLANT AT POST FALLS, IDA.—A contract has been let for the construction of a power plant at Post Falls, Ida., for the Washington Water Power Company. The contract has been secured by Tacoma, Wash., contractors—Charles S. Bihler and Nelson Bennett. It is understood that about $130,000 is involved in the contract. The work contemplates the construction of dams across the Spokane river, at Post Falls, where the stream leaves Cœur d'Alene lake. The Washington Water Power Company intends to utilize the power for the generation of electricity. It is expected that 20,000 horse-power will be developed.

POWER PLANT IN GRAND RIVER CANON—The Colorado Power and Irrigation Company is about ready to begin the erection of a power plant at Glenwood Springs, Col. From the headgate at the upper end of the Grand river, known as Shoshone falls, water will be conveyed through steel flumes and tunnels to the power plant, a distance of about two and one-half miles. The flume will have a fall of four feet to the mile. Contracts have been secured sufficient to show that the company will have an ample market for all the power it can produce. It is expected that at least 40,000 horse-power will be the initial production.

NEW ELECTRIC LINE IN NEW JERSEY—The New York & North New Jersey Rapid Transit Company has filed a charter at Trenton. It purposes to run electric trains from Weehawken to Paterson in fifteen minutes. The capital stock is $200,000, but is soon to be raised to $7,000,000, and construction work will begin shortly. A tunnel will be run through the Palisades, and the line will be elevated part of the way. The incorporators include John W. Griggs, William Barbour, Marcolm R. McAdoo, John R. Lee, Henry Parmelee, E. L. B. Gardiner and Howard Sprague. The length of the line will be about thirteen and one-half miles, as against seventeen, which is the length of the shortest line at present in operation.

MUNICIPAL IMPROVEMENTS IN VIENNA, AUSTRIA—Tenders will be invited shortly by the municipality of Vienna, Austria, for the execution of the following work: extension of the tramway system, cost 6,150,000 crowns (about $1,280,000); establishment of a second water system, cost 2,900,000 crowns (about $600,000); construction of bridges, cost 900,000 crowns (about $177,000); extension of electric light system, cost 6,000,000 crowns (about $1,245,000); paving works, cost 2,697,000 crowns (about $560,000); construction of a market, cost 400,000 crowns (about $83,000); of a central abattoir, cost 500,000 crowns (about $100,000), and of a museum, cost 50,000 crowns (about $10,000); works at the central cemetery, cost 1,300,000 crowns (about $270,000).

NEW MICHIGAN POWER PLANT—The White River Power Company has been organized for the purpose of constructing a double dam across the White river, at Whitehall, Mich., with a capital of $1,500,000. The first dam will be built seven miles from Whitehall, and will develop a minimum of 4,500 horse-power. The second dam will be built directly at the back-water of the first, and will develop 3,000 horse-power. The dams, overflow walls and power-house will be built of cement bricks, which will be manufactured by the company in a mill of its own near the dam. The company contemplates the furnishing of light and power to Whitehall, Fremont, Montague and Hesperia. In connection with the building of the power-house the building of the Muskegon-Oceana electric line will be taken up, the power to be supplied by the company.

MEXICAN ELECTRICAL NOTES—Manuel Alonzo, of Vera Cruz, has been granted a concession to utilize the water power of the Antiga river for generating electric power. The electrical energy will be used to operate manufacturing establishments in the neighborhood. A large power plant is to be installed at Magdalena, Mexico, and electric power will be transmitted to a stamp mill at Cerro Prieto, Sonora, thirty-five miles distant. In the state of Coahuila the International Railway Company has finished the construction of a line of railway between Mesquite and the El Carbon coal mines. The property is being operated in the interest of the railroad company. The alcalde of Lajos, state of Jalisco, Mexico, has entered into a contract for the installation of an electric light plant. A plan is under way for the installation of a power plant in the district of Ejutla, in the state of Oaxaca. This will be a water-power development, and a concession has been requested for the use of 2,000 litres per second of the water from the river Miahuatlan.

LARGE IMPROVEMENTS ON ELECTRIC RAILWAYS IN THE NEIGHBORHOOD OF SYRACUSE, N. Y.—The various electric railway companies operating in and around Syracuse, N. Y., are contemplating improvements during the coming year, which will cost in the neighborhood of $3,000,000. The Syracuse Rapid Transit Company contemplates double-tracking a number of its lines and purchasing a large amount of rolling stock. The Auburn & Syracuse road will double-track about five miles of its lines west of Syracuse, and will develop a large park. The company will also make improvements on a recently acquired steamboat line on Skaneateles lake. The Syracuse & South Bay road will spend about $400,000 in developing its property at South Bay and on Frenchman's and Dunham's islands. The Syracuse, Lakeside & Baldwinsville road will expend about $30,000 in extending its line over a new route from Stiles to the outskirts of the town of Baldwinsville. The Syracuse & Suburban company will spend considerably over $10,000 in minor improvements. The Rochester, Syracuse & Eastern road will spend a large amount in completing its line from Syracuse to Lyons, N. Y.

REORGANIZATION OF THE MEXICAN TELEPHONE COMPANY—A circular issued by the stockholders of the Mexican

Telephone Company announces that the Mexican government has granted the company a concession for a term of thirty years. This concession is conditioned upon the company's placing all cables and wires within a prescribed area underground. This will necessitate immediate work on the new system, since failure will mean forfeiture of the franchise. The company will require $200,000 for installing the underground equipment. It is stated that the Mexican Telephone and Telegraph Company will be formed to succeed the present company. It will have a capitalization of $300,000 preferred stock, and $700,000 common stock. The new company will issue $250,000 in twenty-year five-per-cent bonds, which have already been underwritten, thus securing all the necessary cash for immediate commencement of the work. The new company will offer to the stockholders of the old company one share of preferred stock and two shares of common stock for every nine shares of the present outstanding stock. A special meeting of the stockholders, to vote on the transfer of the property to the new company, is to be held in New York city on February 23.

THE CONTROL OF WIRELESS TELEGRAPHY—Some time ago tentative plans were outlined, giving to the United States navy department the control of all wireless telegraph systems along the coast of the United States and at all outlying possessions. The possibilities of so broad a scheme of government control excited a great deal of controversy on the part of the private companies which had either installed or had in view the installation of wireless telegraph stations. The administration's latest views on this subject have been embodied in a bill draughted by the commissioner of navigation, and made public in Washington, D. C., on January 27. This bill is to be the subject of further revision by the United States cabinet. It provides that no person or corporation shall use any apparatus for wireless telegraphy in the United States or on any American vessel, except it be licensed by the secretary of commerce and labor. Persons exchanging messages or signals between points in the same state or on behalf of the American government are to be exempt from this requirement. The official license shall provide that the president in time of war or public peril may close any wireless station or authorize its use by the government. The president is empowered to establish regulations which shall prevent interference between the navy and military wireless telegraph stations and the private or commercial stations. Each licensed station is to be required to answer calls and signals from any other licensed station, and to receive all such messages or signals offered for transmission to a neighboring station, the rate to be that customarily required for such service. This requirement is to be observed regardless of the system used, on pain of revocation of the license of the offending person or corporation. Operation of any apparatus for wireless telegraphy on a foreign ship, while that ship is in American waters, shall be in accordance with the regulations prescribed by law. Government stations are prohibited from competing for commercial messages with licensed wireless stations.

TELEPHONE AND TELEGRAPH.

SONNENBURG, OHIO—The Sonnenburg Telephone Company is extending its lines to West Lebanon.

YOUNGSTOWN, OHIO—A movement is on foot in Champion and Bristol townships to organize a farmers' telephone company, having service with the Warren & Niles Telephone Company.

BESSEMER, ALA.—The Southern Bell Telephone Company has closed a contract with the Bessemer Coal, Iron and Land Company for the erection of a building to be used as an exchange.

ALTON, ILL.—The Central Union Telephone Company is rebuilding its entire system in Alton, and expects to begin using its new exchange March 1. The new instruments will be of the automatic type.

ALTON, ILL.—The Suburban Telephone Company has secured a franchise in Webster Groves, and has made arrangements to extend its service to that place. The company expects to have its system in operation in Webster, Kirkwood, Ferguson and Clayton shortly.

JOHNSTOWN, PA.—The stockholders of the Johnstown Telephone Company will meet March 21 to decide whether or not the capital stock shall be increased from $200,000 to $400,000. It is proposed to double the capital so that many improvements now planned can be completed.

BLOOMINGTON, ILL.—The National Telephone and Electric Company, of Clinton, Ill., has purchased the Clinton, Vaynesville, Farmer City, Wapella, Weldon, Mansfield and Dewitt exchanges, and a number of farmers' lines in Macon, Piatt, Dewitt, Champaign, McLean and Logan counties for $100,000.

WILLIAMSPORT, PA.—The residents of White Deer Valley will soon organize a telephone company, the lines of which will extend from Elimsport to Montgomery. About thirty-five telephones will be subscribed for. A committee has been appointed to look into the matter of the cost of installing the system.

COSHOCTON, OHIO—The name of the Farmers and Merchants' Telephone Company will in a short time be changed to the Coshocton Telephone Company, and the company will be reincorporated, and the capital stock increased from $15,000 to $30,000. A resolution to this effect was passed at the annual meeting of the stockholders at Warsaw. With the additional capital the lines are to be improved and extended during the coming year. The company is composed of 176 farmers and merchants of Coshocton County.

PITTSBURG, PA.—The annual meeting of the Pittsburg & Allegheny Telephone Company's stockholders was held recently, when the following directors were elected: R. C. Hall, J. G. Splane, H. B. Beatty, D. P. Reighard, R. H. Binns, J. M. Clapp, Ralph E. Flinn, George R. Webb, John S. Weller. The directors organized by choosing the following officers: J. G. Splane, president; John S. Weller, vice-president and general counsel; R. C. Hall, treasurer; T. G. Davis, secretary and assistant treasurer. The executive committee consists of President Splane, R. C. Hall, Ralph E. Flinn and John S. Weller. Over 5,000 additional telephones were installed in Allegheny County, which is known as the "Pittsburg District," making a total of over 15,000 telephones in this district. The most remarkable feature of the company's business is the increase in its long-distance service, which increased over three hundred per cent, compared with previous year.

OBITUARY NOTICE.

MR. GEORGE S. BOWEN died on Thursday morning, January 12, at his home in Elgin, Ill. Mr. Bowen was born at Ingham's Mill, Manheim, Herkimer County, N. Y., November 30, 1829. He was mayor of Elgin in 1872 and 1873. In 1872 Mr. Bowen assisted in organizing the Elgin Board of Trade. He was one of the organizers of the National Electric Light Association, and was made an honorary member of this body in 1890. He was nominated for Congress in the Chicago district on the Peter Cooper ticket in 1876. He served in many public capacities and in industrial, social and religious offices. He was treasurer of the Grace Methodist Episcopal Church, Chicago, Ill., for eight years, and president of the Orphan Asylum, Chicago, for two years. He was one of the principal organizers and builders of the Chicago & Pacific Railway. During the past few years he has been president of the North Pacific Trading Company, with offices in Chicago and Tokio, Japan

LEGAL NOTES.

STORAGE BATTERY LITIGATION—In the United States Circuit Court for the Southern District of New York, the Electric Storage Battery Company, Philadelphia, Pa., on February 4, 1905, filed a bill, accompanied by a motion for a preliminary injunction, against the National Battery Company, for alleged infringement of the Exide battery plate, made under the Bradbury-Stone patent, owned by the Electric Storage Battery Company.

DECISION IN THE UNDERRUNNING TROLLEY PATENT—Judge Wallace handed down an opinion on January 23, 1905, in a suit in which was involved the Van Depoele reissue patent No. 11,872, on the underrunning trolley. The opinion was filed in the United States Circuit Court of Appeals, second circuit, and reversed the decision of the lower court. The suit was brought by the Thomson-Houston Company, complainant-appellant, against the Black River Traction Company, defendant-appellee.

PERSONAL MENTION.

MR. JOHN J. CUMMINS has been elected president of the Syracuse Lighting Company, Syracuse, N. Y., to succeed Mr. Ceyton H. Lewis. Mr. Cummins was formerly vice-president and general manager of the company.

MR. E. E. DOWNES has taken charge of the Petaluma & Santa Rosa railway, as general manager, to succeed Mr. A. D. Bowen. Mr. Downes was formerly president of the Winnebago Traction Company, of Oshkosh, Wis.

MR. CHARLES S. GLEED, of Topeka, has been elected president of the Missouri & Kansas Telephone Company, which operates the Bell company in Kansas City, Mo. He succeeds Mr. Alonzo Burt, who recently resigned.

COLONEL FRANCIS V. GREENE, general manager of the Ontario Power Company, recently delivered a talk to the Buffalo Young Men's Christian Association on the subject of "The Electrical Development of Niagara Falls."

MR. FREDERICK MACKINTOSH has taken the position of manager of the panel and switchboard department with Waterbury & Company, of Brooklyn, N. Y. He has been connected with the General Electric Company, in Schenectady, for the last fourteen years.

MR. EDMUND P. ERB, local manager of the Wisconsin Telephone Company, at Racine, Wis., has been appointed district manager, with charge of all the exchanges and toll lines at South Milwaukee, Kenosha, Burlington, Elkhorn, Lake Geneva and Delavan. He will be succeeded as local manager by Mr. R. E. Browne.

MR. JOHN M. DIVEN has accepted the position of superintendent of the Charleston, N. C., Water and Lighting Company. He has resigned his position as secretary and treasurer of the Elmira, N. Y., Water, Light and Railroad Company, and a farewell dinner was recently tendered him by the officers of the latter company.

MR. CHARLES J. GLIDDEN, well known in telephone circles, is making a tour of the world in an automobile. A cablegram from him announces that he has reached the southernmost point in the world which it is possible to reach in such a vehicle, namely, Bluff, New Zealand. Mr. Glidden has already covered 21,438 miles, 1,145 of which were in New Zealand.

MR. R. A. SCHOENBERG, of the Sarco Company, New York city, was a visitor to Chicago during the past week. Mr. Schoenberg reports a brisk trade in the line of electrical specialties manufactured by the Sarco Company. The Sarco Company has recently placed on the market a number of electrical adaptations which are meeting with great success.

MR. THOMAS FITZGERALD, JR., has resigned as general manager of the Lexington Street Railway and Electric Light Company, Lexington, Ky., to accept a position with the Cincinnati, Ohio, Traction Company. He will be in the executive office, holding the position of assistant to Mr. Dana Stevens, who is head of the operating department, and also vice-president of the company.

MR. ALBERT CARR has taken charge as chief engineer of the Necaxa electric works of the Mexican Light and Power Company. He takes the place made vacant by the resignation of Mr. Hugh L. Cooper. Before his appointment, Mr. Carr was division engineer for the Interborough company, of New York city, and prior to that was identified with Mr. F. S. Pearson, who is constructing the Necaxa works.

DR. S. S. WHEELER is proposed by his friends as a suitable candidate for the presidency of the American Institute of Electrical Engineers. It is no disparagement of others who may have ambition in this direction to say that we believe Dr. Wheeler would make a strong and zealous executive of the Institute and his election would bring to its head a man of affairs and experience at a very timely period in the life of this progressive organization.

MR. H. S. REYNOLDS has resigned as general manager of the Columbus Railway Company, Columbus, Ga. It is understood that Mr. Reynolds comes to New York and will be associated with J. G. White & Company. Mr. Reynolds went to Columbus four years ago, when the Stone & Webster Company purchased the street railway lines at that place. He has since been instrumental in making many improvements in the service.

MR. FREDERIC NICHOLLS delivered an interesting address to the members of the Empire Club, of Toronto, Ontario, on January 19, 1905. His subject was "Niagara's Power: Past, Present and Prospective." Mr. Nicholls is interested in a number of large electrical enterprises, and is quite prominently known in the electrical field. He is an ex-president of the National Electric Light Association. Mr. Nicholls spent some time in New York recently on his way to Hot Springs.

ELECTRICAL SECURITIES.

One of the notable features of recent stock market dealings is the continued investment in bonds. Notwithstanding the good percentages which are being offered on many loans, and opportunities for speculation, the bond market is easily the leader in financial operations. For some time past there has hardly been a single issue which bore any resemblance to stability which has not been strongly supported. The cause of this can not merely be due to professional manipulation, and must have for its continuance a reasonable assurance that the present rate of progress in all forms of industry will not slacken. Railroad earnings are reflecting an increased business activity, and there are rumors to the effect that increased dividends will follow. If this be the case it seems unlikely that there will be any withholding of funds for the extending of present operations and the creation of new organizations. From almost every section of the country reports are received indicating a greater readiness to begin new construction than has been the case for some time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 4.

New York:	*Closing.*
Brooklyn Rapid Transit	61⅜
Consolidated Gas	203½
General Electric	186⅝
Interborough Rapid Transit	208¼
Kings County Electric	200
Manhattan Elevated	170
Metropolitan Street Railway	117½
New York & New Jersey Telephone	171
Westinghouse Manufacturing Company	190

The output of the General Electric Company since the month preceding the presidential election has averaged something above $4,000,000 a month, or at the rate of $48,000,000 a year. It is estimated that in the calendar year 1905 the company will have an output considerably in excess of $50,000,000.

Boston:	*Closing.*
American Telephone and Telegraph	145
Edison Electric Illuminating	250½
Massachusetts Electric	59
New England Telephone	137
Western Telephone and Telegraph preferred	100

The directors of the New England Telephone and Telegraph Company have declared a regular quarterly dividend of $1.50 per share, payable February 15.

Philadelphia:	*Closing.*
Electric Company of America	10½
Electric Storage Battery common	76
Electric Storage Battery preferred	76
Philadelphia Electric	10
Philadelphia Rapid Transit	24¾
United Gas Improvement	108½

Chicago:	*Closing.*
Chicago Telephone	140
Chicago Edison Light	155
Metropolitan Elevated preferred	64
National Carbon common	42½
National Carbon preferred	115
Union Traction common	13¼
Union Traction preferred	50

Chicago Telephone directors have reelected officers.

South Side Elevated averaged for January 84,659 passengers, a decrease of 2,942.

ELECTRIC RAILWAYS.

ITHACA, MICH.—The Alma Sugar Company has projected an electric line from Rathbone, *via* Beebe, to Alma.

KEYSER, W. VA.—The town council of South Keyser has granted a franchise to the Keyser, Burlington & Petersburg electric line.

VINELAND, N. J.—It is reported that the Central Railroad will convert its present road from Winslow, *via* Vineland, to Bay Side into a third-rail electric system, and run cars every hour.

WASHINGTON COURT HOUSE, OHIO—The Washington Court House city council has granted a franchise to the Springfield, Charleston, Washington Court House & Chillicothe Traction Company.

NEWARK, N. J.—The Millburn township committee has passed an ordinance permitting the Morris County Traction Company to construct an electric road from the Millburn station to the Springfield township line.

FORT WAYNE, IND.—The town council of Churubusco has, by a unanimous vote, granted to the proposed Fort Wayne & Goshen electric line a franchise through the streets of that town. Work on the road must begin within ten months.

YOUNGSTOWN, OHIO—The Sharpsville council has passed an ordinance granting the Shevango Traction Company a franchise through the borough. The company expects to have cars running from Sharon to Conneaut lake by June 1.

BOSTON, MASS.—James F. Shaw, the promoter and builder of the Boston & Worcester trolley road, has filed at the State House a bill for a high-speed electric railway from Boston to Providence. The bill provides that the capital shall be $1,500,000.

ROCKVILLE, MD.—The mayor and council of Rockville have agreed upon an ordinance under which the Washington & Rockville Electric Railway Company will be allowed to extend into the town its tracks, which now end at the eastern limit of the town.

BOSTON, MASS.—The plans of the Nahant & Lynn Railroad Company have been completed. The capital of the road is to be $50,000, and the directors will be W. H. Southwick, Nahant; E. E. Strout, Nahant; Clifton Coburn, Lynn; G. E. Bolonga, Lynn; J. A. Carahar, Nahant; C. C. Johnson, Nahant, and E. H. Braun, Nahant.

SHARON, PA.—Sharpsville council has granted a franchise to the Shenango Street Railway Company to lay its tracks on a number of streets of the borough. The company pays the town a bonus of $1,000, and agrees to pay two per cent of the gross receipts collected from people boarding the cars in Sharpsville should the population of the town reach 8,000.

BANGOR, PA.—Announcement has been made that the Bangor & Portland Traction Company contemplates the extension of its trolley line from Bangor, through Portland, to Delaware Water Gap and Stroudsburg. It is expected that the run from Bangor to the Gap may be made in one hour, making it possible to go from Easton, a distance of about thirty miles, to the Gap in two hours.

SPRINGFIELD, MO.—As a result of a meeting of the directors and stockholders of the Springfield Traction Company final action was taken whereby the direct management of the street railways of Springfield was taken over by Springfield men. H. B. McDaniel, W. B. Sanford and Arch McGregor were elected to take the places of the St. Louis directors, R. C. Kerens, S. W. Fordyce and L. M. Rumsey, who resigned after selling their holdings to Messrs. Sanford, McDaniel and Murray.

CLEVELAND, OHIO—The stockholders of the Cleveland, Painesville & Eastern Traction Company have reelected the board of directors for another term, as follows: C. W. Wason, president; J. A. Beidler, vice-president; C. A. Post, treasurer; H. A. Everett, E. W. Moore, Fred Storm, Thomas Merry. The shareholders of the Cleveland, Painesville & Ashtabula Railroad Company have also reelected directors and officers. The report of the treasurer shows that for the first six months of operation the receipts were enough to pay the expenses and fixed charges.

BRANTFORD, ONTARIO — The Canada-Middlesex railway, which is applying to the Dominion parliament for a charter, is to be an electric road, and it has very strong financial backing. The four principal cities on the route are St. Catharines, Brantford, Woodstock and London. From Brantford to Woodstock the road will go *via* Burford. It is not the intention of the promoters to use the highways of the various municipalities to any extent. Their object is to build from point to point in as straight a line as possible. Work will be commenced on the new road as soon as the necessary legislation can be secured.

WORCESTER, MASS.—The promoters of the new Providence & Worcester Street Railway Company have filed with the Worcester board of aldermen a petition for a double-track location from the Milbury line through Greenwood street to the present terminus of the Worcester Consolidated Street Railway Company, with which it will connect, and over whose tracks it will run cars into the centre of the city. Representatives of the company in Worcester say they have secured the right of way through all the towns between that city and Providence, and that petitions will be filed for double tracks in the large towns along the line.

TOLEDO, OHIO—The annual meeting of the Toledo, Port Clinton & Lakeside Electric Railway Company and the Toledo Interurban Construction Company, incident thereto, has been held. The election of the railway company resulted as follows: president, P. McCrory; vice-president, L. E. Flory; treasurer, H. R. Klauser; secretary, Hugh Schunck. The other directors are: Arthur Klauser, Theodore Schmidt and G. W. Luckey. In the case of the Construction company old directors were reelected, except in the case of D. H. James, who retires. The vacancy was filled by the election of G. W. Luckey. The other directors are: Herman R. Klauser, Arthur Klauser, Theodore Schmidt, Harry Thompson, L. E. Flory, J. Powers, James Pheatt and P. McCrory. The officers of the Construction company have not yet been chosen. The company will go on with the completion of the road to Lakeside as soon as the weather permits in the spring.

COLUMBUS, OHIO—The prospectus of the Cleveland, Wooster, Mt. Vernon & Columbus Railway Company has been issued by the board of directors of the company, which is composed of F. W. Jones, president and treasurer, Mt. Vernon; J. J. Vail, first vice-president, Brooklyn, N. Y.; E. F. Shelley, second vice-president, Loudonville; J. A. Tilton, secretary, Mt. Vernon, and J. B. Graham, general counsel, Mt. Vernon. The promoters of the company say that it has been incorporated for the purpose of building an electric line between Wooster and Columbus, connecting at the former city with the Cleveland & Southwestern Traction Company. The line to Columbus will be 105 miles long, with a twelve-mile branch to Mansfield, and will traverse the counties of Wayne, Holmes, Knox, Ashland, Richland, Licking and Franklin. While the capital stock is at present but nominal, the promoters say that it will be increased to $3,000,000 in a few weeks, and that an equal amount of five per cent twenty-year bonds will be issued. The officers state that work will be begun upon the line in the spring.

WASHINGTON, PA.—The annual meeting of stockholders of the Washington Railway and Electric Company and connected companies for the election of directors was held January 21. Directors and officers of the various companies were elected as follows: directors, George Truesdell, George W. Young, James B. Jackey, S. L. Schober, Jr., Allan L. McDermott, R. T. W. Duke, Jr., George H. Harries. Officers: Allan L. McDermott, president; George H. Harries, vice-president; James B. Lackey, secretary and assistant treasurer; W. F. Ham, treasurer and assistant secretary. Potomac Electric Power Company: directors, George Truesdell, S. L. Shober, Jr., George H. Harries, James B. Lackey, W. F. Ham, George W. Young, Allan L. McDermott, H. W. Fuller and R. T. W. Duke, Jr. Officers: Allan L. McDermott, president; George H. Harries, vice-president; James B. Lackey, secretary and assistant treasurer; E. S. Marlow, treasurer and assistant secretary. City & Suburban, Anacostia & Potomac, Brightwood & Georgetown and Tennallytown lines: directors, George W. Young, George Truesdell, S. L. Shober, Jr., H. W. Fuller, Allan L. McDermott, James B. Lackey, W. F. Ham, R. T. W. Duke, Jr., and George H. Harries.

ELECTRIC LIGHTING.

GRIDLEY, CAL.—The Gridley Electric Light and Power Company will erect a new two-story building.

GRIFFIN, GA.—The city is improving its light and water plant, by putting in two additional boilers.

WOODHULL, ILL.—Murdock and Field, of Galesburg, have purchased the Oneida Light and Power Company's electric light plant.

JACKSONVILLE, ORE.—A franchise has been granted to the Condor Water and Power Company to furnish electric lights for Jacksonville.

DIXON, ILL.—The plant of the Dixon Power and Lighting Company has been purchased by H. C. Higgins for the Lee County Lighting Company. The price was $200,000.

WILKESBARRE, PA.—C. H. Geist, of Chicago, and C. B. Kelsey, of Grand Rapids, Mich., have concluded to purchase the stock of the various light companies operating in the west side towns.

ALEXANDRIA, IND.—William F. Stinson, of Alexandria, has closed a deal looking to the purchase of one-half of the capital stock of the Alexandria Light and Power Company, the consideration being $10,000. The plant has a ten-year contract to supply Alexandria with light.

JEFFERSON CITY, TENN.—A movement is being made by the Jefferson City Electric Light Company to replace the plant burned a short time ago. Steam power will be used, and it is thought the city will be lighted very soon. The new plant will be within the corporate limits.

LOGANSPORT, IND.—The Fort Wayne & Wabash Valley Traction Company has proposed to the Logansport city council to supply all the electric light the city wants at a lower rate than the present municipal plant charges. The offer is to go into effect as soon as the $1,000,000 power-house is built at Fort Wayne.

PORTLAND, ME.—The South Paris village corporation is considering the matter of furnishing its own electric lights. A bill was introduced in the legislature of 1903 authorizing the village corporation to establish a municipal lighting plant, but was referred to the legislature of 1905. It was voted at a recent meeting to raise $500 to pay the expenses of this movement.

KNOXVILLE, TENN.—Reports state that J. E. Durham, representing a Philadelphia, Pa., syndicate, together with E. H. Mather, an electrical engineer, of Portland, Me., is investigating the water power of the Holston river, on which it is planned to build a power plant for supplying Knoxville with light and water. Sam. L. King, president of the Goodson Water Company, of Bristol, is also said to be interested.

BINGHAMTON, N. Y.—At a meeting of the stockholders of the Binghamton Light, Heat and Power Company the following board of directors was elected: George W. Dunn, J. J Douglas, W. B. Dinsmore, Jr., Chauncey Eldridge, C. F. Hotchkiss, J. B. Hart, F. W. Jenkins, T. M. R. Meikleham and George F. O'Neil. The directors elected the following officers: president, George W. Dunn; vice-president, J. B. Hart; treasurer, W. B. Dinsmore, Jr.; secretary and attorney, F. W. Jenkins.

EBENSBURG, PA.—A reorganization of the Ebensburg Light, Heat and Power Company has been effected by means of which a number of prominent citizens not connected with the corporation in the past will hereafter participate in the management. Heretofore the board of directors has consisted of J. W. Leech and John W. Kephart, and S. L. Riggs, manager of the plant. The board membership has been increased to five, the present members being Messrs. Kephart, Leech, A. W. Buck, M. D. Kittell and C. H. Barker. Mr. Kephart remains president, Mr. Barker is made vice-president, and Mr. Buck treasurer.

BATTLE CREEK, MICH.—The Kalamazoo Valley Electric Company at present owns three large power plants on the Kalamazoo river, at Allegan, Otsego and Plainwell, and the electric current generated at these power plants is transmitted to Jackson, supplying power for the Kalamazoo & Battle Creek interurban, and the Jackson & Battle Creek interurban, and power for various establishments, besides for the Battle Creek & Kalamazoo, Battle Creek & Jackson city electric car lines. The company now contemplates the expenditure of a large amount of money for the purpose of installing more power plants in various parts of western Michigan, so as to furnish power to several new electric interurban lines contemplated in that part of the state, and also for the purpose of furnishing lighting and heating to various cities. At present the company's franchise calls simply for the running of one high-tension wire through Battle Creek for the purpose of furnishing power. The common council has, however, granted a new franchise, giving the company the use of all the streets of the city, and allowing it to furnish light and heat. It is announced that the company will absorb the present Battle Creek Electric Light Company.

NEW COMPANIES.

ANDERSON, IND.—The Perfection Magneto Company has been incorporated with a capital of $20,000 by F. G. Borden, R. E. Creighton and M. K. Creighton.

ROCHESTER, N. Y.—The Denico General Electric Company has been incorporated with a capital of $250,000, to manufacture fire-alarm, telephone and telegraph apparatus.

CLEVELAND, OHIO—The Electrical Manufacturing Company, capitalized at $5,000, has been incorporated by E. Y. Mackey, L. L. Leese, W. E. Rice, George J. Vaughn and N. Herman Thiessen.

ROCKWOOD, ILL.—The Sells, Miller, Santee Company has been organized to deal in electrical sundries. The company has a capital stock of $2,500, and was incorporated by J. Frank Sells, Harry J. Miller and Charles F. Santee.

CHICAGO, OHIO—The Guarantee Telephone and Equipment Company, of Chicago, Ill., has been incorporated by L. Anderson, Albert Duce and Donald E. Turner. The capital is $2,500. The company will manufacture telephones and electrical supplies.

ASTORIA, N. Y.—The Sunswick Company has been organized to manufacture electrical supplies. The capital stock is $25,000, and the directors are George H. Selleck, New York; James H. Thompson, Brooklyn, and George H. Hawkins, Long Island City.

LOUISVILLE, KY.—The Home Electric Company has filed articles of incorporation in the county clerk's office with a capital stock of $3,500. The concern will do a general business in electrical goods. The incorporators are Edward J. Theobald, John C. Fries, Sam. Z. Lorch, Percy Sternau.

RED BANK, N. J.—The Wheelon Company has been organized to manufacture a device for automatically replacing trolley poles on the wires when they slip. Robert T. Preston, the inventor, is secretary of the company, which is capitalized at $20,000. William A Hopping is president, and George C. Hopping, treasurer.

ROME, N. Y.—George A. Clyde has organized a stock company with a capital of $40,000, for the manufacture of insulated electrical wire, machinery and apparatus, the new company to be known as the Fort Stanwix Electrical Works. The directors for the first year are Newton H. Jones, George A. Clyde, W. R. Huntington, W. W. Parry and Thomas G. Nock.

JERSEY CITY, N. J.—The United States Portable Electric Light and Power Company has been incorporated to manufacture, install and maintain electric light plant equipments. The company has a capital of $125,000, and the following are the incorporators: Arthur D. Wright, Brooklyn; Henry W. Waldin, New York; Benjamin C. Raymond, Brooklyn; Newman H. Raymond, Jersey City.

ENGINEERING SOCIETIES.

PENNSYLVANIA STATE COLLEGE BRANCH OF AMERICAN INSTITUTE ELECTRICAL ENGINEERS—At the meeting of the Pennsylvania State College branch of the American Institute of Electrical Engineers, Wednesday evening, February 1, the following programme was given: "Train Lighting in France" was discussed by J. C. Chrisman, and the Institute paper on "The Maximum Distance to Which Power Can Be Economically Transmitted," by Ralph D. Mershon, was read and discussed by B. C. Butler and G. L. Christman.

INDUSTRIAL ITEMS.

THE COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, Mo., announces that it has taken new quarters in Memphis, Tenn., being located in Suite 302, Scimitar Building.

PASS & SEYMOUR, Solvay, N. Y., announce that they have removed their New York office to 1322 Havemeyer Building. Mr. W. Brewster Hall is in charge of this office as sales agent.

THE McROY CLAY WORKS, of Brazil, Ind., are distributing an attractive blotter. The blotter has on the back a calendar for February, and a number of sayings of Eliza Atkins Stone in *Life*.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, is distributing bulletin No. 26, describing switching stations for small or isolated exchanges, and auxiliary cord equipments for telephone work.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, in bulletin "A" reproduces the story of the coal and ash-handling equipment of the Scioto Valley Traction Company's power plant at Reese's Station, Ohio.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, is sending out a neat mailing card advertising the "Buckeye" incandescent lamps. This is part of an extensive follow-up system which the company instituted some time ago.

THE MARSHALL ELECTRIC MANUFACTURING COMPANY, of Boston, Mass., reports an exceedingly brisk demand for its new line of snap switches. It also states that it is taking care of a great number of orders for its new flush rotary switches.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., is distributing a folder describing the advantages of using electric current in the store or home. The folder reminds the consumer that the rates for electric current were reduced on the first of the year.

THE GARVIN MACHINE COMPANY, New York city, is issuing a booklet describing part of the line machine tools manufactured by it. The booklet describes milling machines of various types, grinding machines, slotters, screw machines, tapping machines and drill presses.

THE EWING-MERKLE ELECTRIC COMPANY, 1106 Pine street, St. Louis, Mo., is issuing a circular, which under the title of "Just a Few Thousand Years Ago," calls attention to its line of electrical supplies. It compares the method of doing things in China in bygone times, and the method of doing things to-day.

FRANK B. COOK, 249 West Lake street, Chicago, Ill., is calling attention to his new No. 8 protector for telephone circuits. He states that a number of large orders for it have recently been placed, as well as for his older type No. 244. Another device which he is introducing is a multiple-contact test connector.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, INCORPORATED, Stamford, Ct., has taken orders for one million feet of its creosoted Wyckoff Conduit for underground wires, and for one hundred thousand standard ten-foot creosoted cross-arms, to be delivered for construction work this spring and summer.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., is distributing a handsome reproduction of "The Big Reliable," the famous 5,000-horse-power Allis-Chalmers engine and 3,500-kilowatt Bullock generator which supplied current for the decorative lighting of the World's Fair, St. Louis, Mo., and for operating the electric cars of the St. Louis Transit Company.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, is issuing a catalogue describing its motors and generators. The catalogue contains sixteen pages, and gives dimensions and prices of motors from one to twelve horse-power. The company is sending with the catalogue photographic reproductions of the awards given it at the St. Louis World's Fair.

THE UTICA FIRE-ALARM TELEGRAPH COMPANY, Utica, N. Y., is distributing a catalogue descriptive of the telephone and telegraph apparatus it manufactures. House telephones and long-line telephones are described, and also desk telephone sets, wall telephones, switchboards, extension bells, transmitters, hotel annunciators and other apparatus used in telephone work.

PARTRICK, CARTER & WILKINS announce that on or about February 15 they will remove to their new factory at Twenty-second and Wood streets, Philadelphia. Their new factory will have about double their present facilities for manufacturing annunciators, bells and other specialties in house-goods supplies, for which they report a large and increasing demand.

THE KUSEL & KUSEL AUTOMATIC SWITCHBOARD AND TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., is distributing a forty-eight-page catalogue descriptive of the telephone apparatus manufactured by it. The catalogue describes the "K-Clark-K" automatic telephone system and its application. Desk sets, switchboards, wall telephones and auxiliary apparatus are also described and illustrated.

THE INTERNATIONAL ACHESON GRAPHITE COMPANY, Niagara Falls, N. Y., is sending out "Protection, Resistance, Durability," a handsome and interesting booklet, describing the methods of manufacture in the electric furnace and use of Acheson graphite for paint pigment. Any one interested in protecting metal surfaces from corrosion and decay can obtain this booklet by writing to the International Acheson Graphite Company.

THE APPLETON ELECTRIC COMPANY, 224 Washington street, Chicago, Ill., is calling attention to the new catalogue which it is distributing. The catalogue describes fuse blocks, lightning arresters, fuse links, etc. It desires to call special attention to its new type of fuse block, which it states is different from anything else on the market. In addition to the above articles it manufactures the Marlin cable hangers.

A. L. IDE & SONS, Springfield, Ill., have established a New York office at 11 Broadway, where all export, New England and Middle States business will be transacted hereafter, under the management of Mr. J. G. Robertson. A. L. Ide & Sons are the original manufacturers and patentees of the celebrated "Ideal" engines. These engines are being used extensively in manufacturing establishments, office buildings and for power and electric plants.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is distributing a number of reprints of papers read before the Ohio Electric Light Association, at Sandusky, Ohio, August 18, 1904. These are entitled: "Notes on Incandescent Street Lighting," by K. C. Randall; "Points for Consideration When Purchasing Series Alternating-Current Arc Lamps," by G. Brewer Griffin, and "Instrument Equipment of a Testing Department," by F. Conrad.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, 36-58 West Jackson boulevard, Chicago, Ill., announces that it has equipped with telephone apparatus the following places: Maysville, Mich., one 100-line switchboard; Browns, Ill., one 50-line switchboard; Rossville, Ill., one 50-line switchboard; Eldorado, Ill., one 100-line switchboard; Tilden, Ind., one 100-line switchboard; Freeport, Pa., two 100-line switchboards; Freeport, Pa., one 100-line switchboard; Freemont, Ind., two 200-line switchboards; Vassar, Mich., two 160-line switchboards.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., is distributing No. 1 of vol. i of the "National Electrical Catechism." This catechism is destined to afford to electricians and engineers of every class a great deal of interest and instruction. Beginning with the first principles the catechism deals with the definitions of the electrical units. It is intended eventually to lead up to a very interesting series of questions and answers. A reply postal card is being sent with the first few issues, so that a regular mailing list may be made up. The catechism will be mailed to any one interested in the matter.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., has issued a new catalogue, No. 19,053, covering motor field rheostats. These rheostats are for use in the fields of variable-speed motors, speed control being obtained by field regulation. The rheostats are necessarily high-resistance rheostats with low ampere-carrying capacities. The catalogue covers three types, FM, SM and EM, having four to one, six to one and eight to one tapers in ampere capacity, respectively. The highest catalogued resistance is 2,900 ohms. The rheostat is but eight inches in diameter, and approximately four inches deep, with twenty-four steps. The resistance is in the form of the Ward Leonard enameled resistance units.